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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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The French International Foundry Congress.

International Foundry well-being was carried a step farther last Thursday, as a result of the deliberations of the Committee of the Institution of British Foundrymen on International Relations. It was decided that the most convenient date for the Paris Conference for all concerned was from September 12 to September 15. Mr. H. Cole Estep, the chairman of the American Foundrymen's Association's Committee on International Relations, stated that he expected that the American delegates would arrive in this country about September 1, and would remain in England until the opening of the Paris Conference. A strong committee has been formed amongst the London technical societies, with the local branch of the Institution as a nucleus, to ensure the Americans a hearty welcome. This is a lead which, no doubt, the large provincial centres will follow.

It was put forward by the committee that the formal International gathering should be held on September 12, and a special session for the English speaking community on September 13. Visits to foundries and works in the Paris district and a banquet will fill in the remainder of the Conference period.

After the Conference is over, two tours are being arranged, primarily for the benefit of the American visitors. One party will go to the east of France, to Nancy, Pont à Mousson, Luxembourg and Liége (Belgium), and a second party, by the courtesy of Messrs. Schneider et Cie, to Le Creusot, to inspect the foundry which we described in a recent issue. It should be clearly understood that these tours are extra to the Conference, as they will occupy, perhaps, more time than would be available for most foundrymen, but obviously it will be a great educational opportunity which should be taken advantage of by all possible.

A small sub-committee has been formed to make detailed arrangements, but the members of the Committee on International Relations will be invited to every sub-committee meeting, and will be advised as to progress. This has been decided upon so as to make the appeal as wide as possible. It should be remembered that the members, apart from the general officers of the Institution, are its Branch Presidents. There will thus be no reason why any attached member should not be *au fait* with the developments as they proceed.

Foundrymen must not expect a definite cast-iron programme for a considerable time, especially as to cost, owing to the violent fluctuations of the relative value of the French franc compared with the pound sterling, which obviously affects costs.

The Exhibition, which is to be held in Ecole des Art et Métiers (Arts and Trades Schools), is to be open from September 6 to September 14. The school itself is well worth a visit to Paris for anyone interested in technical education, especially foundry instruction, as it contains a model foundry of a capacity greater than many operating commercially, and much better equipped than the majority.

We sincerely trust that the foundry employers of Great Britain will realise the advantages which such a visit offers, and will assist by granting facilities to their technical staff, and if possible contributing towards their expenses.

Inverse Chill and Volume Changes of Cast Iron.

We felt some gratification in the preparation of the current issue, as both the above subjects had their initial British discussion in this column. Inverse, or internal, chill was first introduced to our readers by an account of Prof. Osann's work. It was soon discovered that the phenomenon was unpleasantly common in this country. It was taken up by Messrs. Poole and Young and other workers, and this week Mr. J. E. Hurst takes the subject much farther, because of its occurrence in centrifugally-cast cast iron. Interest in volume changes was revived in these columns when an article by Mons. Ronceray was reviewed, showing how he made castings without using any form of feeding head or riser. This subject drew large and enthusiastic audiences wherever it was discussed. For most foundrymen, and especially Mons. Ronceray, it will be a pleasure to read the account of Mr. Smalley's excellent research into this subject. Obviously the cost of this research must run into several thousands of pounds, and the thanks of the foundry world are due to the firm concerned for allowing the publication of this work.

London Foundrymen Visit Charlton.

On January 20 members of the London Branch of the Institution of British Foundrymen visited two adjacent works, in the Charlton district, and we feel sure that it would be difficult to find two more interesting works for foundrymen in such close proximity. One was the propeller foundry of Messrs. J. Stone & Company, Limited, of Deptford, and the other Messrs. The United Glass Bottle Company, Limited.

At the former works the visitors were shown the pattern-making, moulding, melting, fettling, and machining departments. The methods used in these works have been fully described by the Branch-President, Mr. Wesley Lambert, in a Paper which he read before the Institute of Marine Engineers, which was published in Vol. 23, No. 236, of THE FOUNDRY TRADE JOURNAL.

The connection between foundry work and bottle making is much closer than is generally imagined. Primarily, there are the melting and annealing operations. At the Charlton plant all the raw materials are ground and mechanically conveyed to the charging aperture at the back of the furnace. The firing is by oil burners utilising recuperated air, based on the Siemens principle. The oil burners, situated on either side of the furnace, are alternately worked, as is the gas in an open-hearth furnace. The front of the furnace is provided with a revolving fore-hearth, over which revolves the glass-blowing apparatus. Associated with this is the second matter of outstanding interest for foundrymen, for the cast-iron moulds, a selection of which appear in Fig. 1, which illus-

interest for foundrymen—the cast-iron moulds—

when made of American or German cast iron, not only stand up some 80,000 rounds, but are capable of being repaired by hammering along the worn edges of the joint and making the iron flow a 32nd of an inch or so on either side. English iron is wont to chip. One British firm, however, is being fairly successful, and the matter is being studied by the B.C.I.R.A.

At an excellent tea, served at the works of Messrs. Stones, the directors and staff of the two companies were thanked, special mention being made of Mr. Geo. Alexander, the chairman of the Glass Bottle Company, and Mr. Geo. Prestidge, of Messrs. Stones, who had accorded permission for the visit.

FIG. 1.—THE MACHINE SHOP AT THE CHARLTON WORKS OF MESSRS. THE UNITED GLASS BOTTLE COMPANY, LIMITED.

Personal.

THE LATE Mr. G. H. W. Grace, of the firm of H. Franklin & Company, Bermondsey, S.E., engineers' furnishers, left £30,591.

THE LATE MR. D. C. WATSON, formerly associated with the South Durham Steel and Iron Company, Limited, and of the firm of Bonniwell & Watson, of Middlesbrough, left £12,294.

MR. W. H. HUTCHINSON has been elected a director of Sir Wm. Arrol & Company, Limited, and will be in charge of the general contracting branch of the business, which is being transferred to London.

MR. L. D. HYLAND, of Hunter and Hyland, Limited, brassfounders, etc., Red Lion Square, London, W.C., who died on December 1 last, left estate of the gross value of £16,603, with net personalty £7,564.

CAPTAIN M. C. JAMES has been appointed general manager to the Mercantile Dry Dock Company, Limited, Jarrow, and elected to a seat on the board. Captain James has been connected with the company for 17 years as assistant to his father, Mr. M. C. James, managing director of the company.

MR. A. H. SPALTON, who has been secretary of Henry Bessemer & Company, Limited, for a number of years, has been given a seat on the newly-constituted board of directors of the company, and appointed joint managing director. He has been in the service of the company for nearly 20 years.

MR. JOHN MILES, son of Mr. T. V. Miles, a director of Newton, Chambers & Company, Limited, Sheffield, has now joined the firm of Freyn, Brassert & Company, Limited, 38, Victoria Street, Westminster, S.W.1. Mr. John Miles was in America the whole of last year with Freyn, Brassert & Company, of Chicago, furnace engineers.

Testimonial to Mr. Hogg.

Members of the Institution of British Foundrymen will be interested to learn that a fund is being raised for the purpose of presenting a testimonial to Mr. Jos. Hogg. It is hoped that many members outside the Lancashire Branch will take this opportunity of showing their appreciation of the excellent work performed by Mr. Hogg as Branch-Secretary. Subscriptions should be sent to the Hon. Secretary, Mr. T. Makemson, 21, Beresford Road, Stretford, Manchester, as soon as possible. The fund will be closed on February 3, 1923.

Internal Chill in Castings.

By J. E. Hurst (Carnegie Scholar).

The occurrence of local areas of hard, white iron in the surface of grey iron castings is comparatively common in everyday works practice. It is not easy to form an opinion as to the exact cause or the manner of formation of these spots, and from time to time considerable discussion has been given to this subject.

A somewhat rarer occurrence is the presence of hard, white iron in the internal portions of castings surrounded by an outer surface of grey machineable iron. This phenomenon has attracted considerable attention, and has now come to be known under the various titles, inside, internal, inverse or inverted chill. All these terms suffice to amply describe the character of the phenomenon. An explanation of these phenomena, in addition to its practical importance, is of considerable theoretical importance, as vindicating or otherwise the present-day views on the manner of formation of graphite in cast iron.

The writer has frequently met this phenomenon in the production of cylindrical castings and round bars from metal moulds. A summary of the chemical analysis of the white and grey portions of internally chilled specimens is given in the following table:—

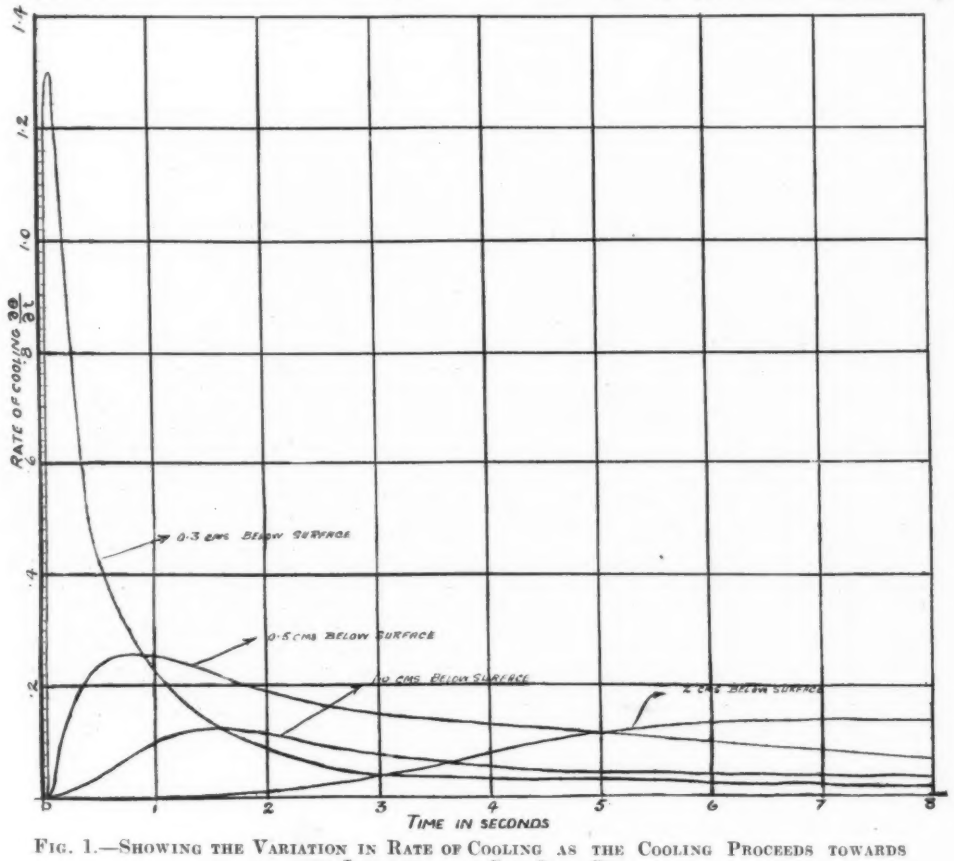


FIG. 1.—SHOWING THE VARIATION IN RATE OF COOLING AS THE COOLING PROCEEDS TOWARDS THE INTERIOR OF A CAST-IRON BAR.

TABLE I.—*Compositions of White and Grey Areas in Inverse Iron.*

	Tot. C.	Gr.	CC.	Si.	Mn.	S.	P.	Authority.
White ..	2.94	—	—	2.40	0.25	0.202	1.45	Poole.
White ..	2.92	0.12	2.80	2.30	0.25	0.23	1.55	,,
White ..	2.77	—	—	2.79	0.25	0.236	1.49	,,
Grey ..	2.94	2.18	0.81	2.45	0.26	0.17	1.48	,,
Grey ..	2.94	1.99	0.95	2.42	0.26	0.24	1.55	,,
Grey ..	2.77	1.87	0.90	2.99	0.24	0.25	1.53	,,
White ..	3.40	0.35	3.05	2.00	0.36	0.152	0.97	Osann
Grey ..	3.43	2.26	1.17	2.00	0.36	0.146	0.98	,,
White ..	3.45	—	—	2.56	1.59	0.075	0.080	A't'or
Grey ..	3.42	2.91	0.51	2.58	1.61	0.08	0.075	,,
White ..	3.25	—	—	2.77	0.78	0.12	0.15	,,
Grey ..	3.28	2.63	0.65	2.79	0.78	0.11	1.13	,,

W. J. Keep was probably one of the earliest to attempt an investigation of this problem. It has since been discussed by several investigators, both in Europe and America. These discussions are summarised in the FOUNDRY TRADE JOURNAL, January 11, 1923, and amongst the most important may be mentioned those of Mr. Poole, in this country, and Prof. Osann, in Germany.

A series of experiments are also recorded by West ("Foundry," June, 1912). This investigator produced an inside chill in specimen bars by quenching the bars in water and other liquids after removing from the moulds at predetermined periods after the commencement of solidification. Unfortunately only approximate chemical analyses of the material used are given. West states that: "The irons used were approximately of the following composition:—Carbon, 2.75 to 3.75 per cent.; silicon, 1.75 to 2.0 per cent.; sulphur, round about 0.06 per cent.; manganese and phosphorus each about 0.04. In cases where a more chillable iron was required, small portions of stick or powdered sulphur were dropped on the top of the molten metal in the hand ladle."

The first series of analyses in the table by Mr. Poole show the following features—a low total carbon content, a high sulphur and low manganese content. For the silicon content the combined carbon in the grey samples is high, a fact which can be ascribed to the high sulphur and low manganese if the castings were generally of a comparatively thin cross section.

In one case there is evidence of some segregation of the sulphur content, and in all cases the silicon content is lower in the white portion than in the corresponding grey portions.

In Prof. Osann's figures there is no evidence of any serious segregation, and we have a case of the presence of inside chill in an iron which, apart from the high combined carbon recorded in the

grey portion, is a perfectly normal cast iron. The Mn content is lower than common practice here.

Chill Castings show Inverse Chill.

Two cases recorded by the writer show the occurrence of internal chill in a normal siliceous hematite iron of high manganese content, and in a high silicon foundry iron of a normal type. These two cases have been selected because of their essential differences in chemical composition from those previously recorded. It will, however, be remembered that these two latter castings have been produced from metal moulds, whereas, so far as is known to the author, all the other cases represent sand castings.

It appears quite clear from these recorded examples that the common explanation of the segregation of the constituents, principally the sulphur, is not sufficient in itself to account for the whole of the phenomena.

On the other hand it is well known that the formation of chilled white iron, apart from the chemical composition, is largely governed by the rate of cooling, and a consideration of the rate of cooling might be of assistance in understanding the formation of inside chill. It should be remarked at this stage that the importance of the initial temperature of the metal, or the casting temperature, was pointed out by Mr. Poole.

In considering the rate of cooling, by making certain assumptions and neglecting certain complications, we are able to derive a conception of the variation in rate of cooling throughout the mass of a casting. The rate of cooling must be clearly understood in a consideration of this kind to be the temperature range passed through in a given period of time.

How Cast Iron Cools.

Considering therefore a plain cylindrical bar of cast iron of sufficient length that the end effects can be neglected, the surface of which is instantaneously cooled from the liquid state to some temperature in the solid state well below the range of maximum graphite formation, we desire to discuss the rate of cooling as a function of the distance within the bar from this cooling surface. If the assumption is made that the direction of heat flow from the bar to the cooling media is in a direction at right angles to the axis of the bar and neglecting the latent heat evolved on solidification, we are able to calculate a series of curves showing the variation of rate of cooling with the time for a series of surfaces within the bar at predetermined depths from the extreme outer surface. Such calculated curves are shown in Fig. 1.

Taking into consideration the aforementioned assumption these curves illustrate the variation in rate of cooling as the cooling proceeds into the interior of a cast-iron bar when cooled instantaneously. In any one surface the rate of cooling commences at zero, and rapidly approaches a maximum, after which the rate of cooling falls away and becomes slower. The rapidity of the increase in the rate of cooling, the magnitude of the maximum rate of cooling, and the rapidity with which the rate of cooling decreases depends upon the distance of the particular surface from the external surface. In other words, these curves serve to show the appreciable lag in attaining the maximum rate of cooling for any given surface inside the bar. The curves apply strictly to a linear consideration of the flow of heat and castings of complicated section could not be considered in such a simple manner.

In actual sand casting practice or even in casting in metal moulds the reduction in temperature is not instantaneous as is assumed in the above curves, and the maximum rate of cooling as indicated in the curve at a depth of 3 mm. is not so great or so rapidly attained under these circumstances. The calculation of an actual practical case would be a matter of considerable difficulty. A conception of the sand-casting case can be obtained by considering the curves transferred and applying to a smaller depth than calculated for. For example, the curve representing the rate of cooling at a depth of one centimetre if considered to be at a depth of 0.3 cm. would more plausibly represent the conditions obtaining in a sand-cast bar.

In an iron of a given chemical composition, it is a well-known fact that the rate of cooling is a vital feature in determining the extent of graphite formation. The extent of graphite formation, however, is not a linear function of the rate of cooling. In any event, other things being equal, there must be a rate of cooling below or above which graphite is or is not formed. In a like manner, other things being equal, and with cast iron of chemical compositions met with in ordinary practice, it is possible to conceive of certain chemical compositions which would invariably be white irons and others which would be invariably grey irons under the particular conditions. This being the case, there must be an intermediate series of chemical compositions of iron which with small variations in the other conditions, principally the rate of cooling, would be either white or grey according to the direction of variation of these conditions. There are, of course, a large number of possible chemical compositions falling within this intermediate zone according to whether those elements which are known to exert an influence on promoting or preventing graphitisation are considered singly or combined. In this connection something of the order of a critical percentage of certain elements, other features of the chemical composition being equal, and for a given rate of cooling, has long been suspected above or below which graphitisation is or is not effected. Traces of such a point are to be found in the standard investigations on the influence of silicon in cast iron.

If we now consider the case of a cast iron whose composition lies within the intermediate zone above referred to for the particular conditions under which it is cast: its normal rate of cooling for surface below the external surface, but near to it, would probably be of the type between the one and two centimetre depth curve illustrated. From this it will be clear that some time will elapse before the maximum rate of cooling is attained. The maximum rates of cooling in succeeding layers will also be attained in quick succession, and the value of the maximum rate will not be much less. This will be appreciated from an inspection of the curves. We thus have a state of affairs in which the *rate* of *cooling* in the outside layers is slower for a certain interval of time than the immediately following layers.

Delayed Surface Cooling Gives Grey Iron.

Now all investigation leads us to believe that the major portion of the graphite formation takes place over a certain temperature range round about the close of the solidification range. If therefore the maximum rate of cooling period of the external layers is delayed so long that this graphitisation temperature range of these layers is past, then these layers will solidify as grey iron. The layers following will reach their maximum rate of cooling period in due sequence, and according to the particular conditions of the case a point will be reached at which the maximum rate of cooling will coincide with the graphitisation period. These layers will then solidify as white iron. This state of affairs will be attained if the initial temperature is not too high, since the rate of cooling is a direct function of the initial temperature. This fact coincides with observations as to the conditions under which inverse chill is formed.

In thin sand castings (and inverse chill is the more commonly observed in such castings) the whole of the internal metal may solidify as white iron, surrounded by a layer of grey iron. The thicker the casting becomes, the more difficult it would be to obtain internal chill (under normal conditions of cooling as initiated), the tendency being for a chilled layer only to exist at some distance below the external surface of the casting where the maximum rate of cooling coincided with the graphitisation period. It will also be observed that as the cooling is more efficient, the less likelihood of the internal chill phenomenon occurring. On the other hand also, if the chemical composition of the metal is not within the intermediate zone, but either *certain* grey or *certain* white for the particular conditions, then the phenomenon cannot occur.

In the case of the two samples recorded by the author, whilst the composition of these is perfectly normal, the samples were cast in metal moulds. A direct result of this increased mean rate of cooling, due to the casting in metal moulds, is to

place these irons in the category of intermediate irons above mentioned. At the same time, however, the rate of cooling curves for the external layers would be altered to the type having a speedier and higher maximum. Therefore, whilst the chances of internal chill are somewhat lessened, if the conditions are such that the maxima are delayed beyond the graphitisation zone, there is a possibility of the formation of an internal chill. As would be expected in such cases, the external layers of grey iron are usually not of great thickness.

A point of interest in connection with the first sample recorded by the author is that this was a cylindrical casting cast by the centrifugal process. In this casting, therefore, the outer layers were subjected to considerable centrifugal pressure. The suggestion has been advanced that the pressure would favour the formation of white iron. In this case this suggestion is not confirmed.

The conditions, therefore, for the formation of an inside chill in castings, without resorting to special methods of quenching at certain periods of the solidification of the castings, are that :—

(a) The chemical composition of the iron shall be intermediate between that which would give certain white or certain grey for the particular conditions under which the casting solidifies.

(b) A low initial temperature of the metal.

(c) Moderate cross sectional thickness.

The conditions of chemical composition satisfying (a) are familiar to most foundrymen and the common ones may be briefly summarised as (1) high sulphur and low manganese, (2) low silicon for the particular type of casting, (3) low total carbon content. In connection with condition (b), the initial temperature will vary with each shade of variation in composition, and in the present state of our knowledge, can only be determined by direct experiment. In large masses of iron it would probably be impossible under practical conditions to obtain internal chill in irons of commercial compositions.

Conclusions.

It would appear that the phenomena of internal chill can be attributed to the lag or period of time which elapses in the cooling down of cast iron before the maximum rate of cooling is attained. If this maximum rate of cooling is delayed, owing to low initial temperature, until the temperature zone of the formation of the major portion of the graphite is passed, then if the composition of the iron is such as can be described as " bordering on chill " the outer layers will solidify grey and the internal layers white.

The influence of segregation phenomena has not been forgotten, and such phenomena in themselves, if of sufficient magnitude, would also be sufficient to explain the production of internal chill. Many cases of internal chill are known where segregation phenomena cannot account for this condition. Artificial alteration of the rate of cooling during the solidification of the metal can also be utilised for the production of internal chill.

Drill Steel Tempering.—In the usual method of tempering steel the drills, after being sharpened, are put in the tempering furnace and subjected to progressively increasing temperatures till, in the opinion of the man in charge, the highest degree in tempering has been reached. However experienced the workman may be, it is generally recognised that this method at its best is often wasteful and faulty. Mr. D. O'Donovan (chief engineer of the E.R.P.M. in South Africa) suggests an additional couple of final operations in a muffled furnace, wherein the jumpers are held in position between magnets placed at the back of the furnace opposite to the cutting face of the drill and springs at the opposite end. When the point is reached at which steel loses its magnetism, and at which it reaches its highest temper, the magnet automatically ceases to hold the steel in position, and this is drawn out by the spring. The advantages claimed for the innovation are (1) greatly increased efficiency of the steel (it is claimed that one drill bit tempered by this process on the average will do the work of two or even three tempered in the usual manner) : (2) non-burning of the steel ; (3) no expert supervision is required, as the work is automatic ; (4) the process will encourage the increased use of jackhammers, which are notoriously hard on drill bits.

German Iron Foundries during Last Quarter, 1922.

The Commercial Secretary at Cologne (Mr. C. J. Kavanagh) has forwarded to the Department of Overseas Trade an extract from the " Deutsche Bergwerks Zeitung," which states that the Association of German Iron Foundries, Dusseldorf, reports as follows :—

The market position of the German iron foundries during the last quarter of 1922 was characterised by the further and considerable mark depreciation. The consequent increase of all costs of production, as well as of raw materials, wages and freight, compelled the foundries to make frequent and considerable increases in prices. Whereas hitherto the Association of German Iron Foundries, in spite of the wage fluctuations in the course of the month, had always bound itself for a whole month to the prices fixed at the beginning of the month in order to contribute to a recovery of economic conditions, it was found necessary as from the end of August to fix the prices every ten days, and subsequently ever seven-eight days, because the Pig-Iron Association, in its turn, could not bind itself for longer terms. The price increase, however, which can be calculated exactly in accordance with the increased costs of production, could not compensate for the disadvantages caused to nearly every branch of industry by the sudden fall of the mark. One of the great drawbacks was the difficulty of obtaining credit, which, in the case of smaller foundries not so well provided with capital, was disastrous. Expenses increased considerably owing to the slow settlement of outstanding accounts, which necessitated a recourse to bank credits, the issue of drafts, as well as reminders both in writing and in person.

German Foundries Still Busy.

In spite of the numerous and considerable price increases, the employment of the German iron foundries in machine castings was good in general. Even if here and there a decrease of orders was noticed, the foundries are passing into the new quarter of 1923 with a good many orders on hand. As in the other industrial branches, this brisk demand is to be attributed to the endeavour of consumers to cover their requirements as favourably as possible before further increases should take place, and invest all available money in goods as a safeguard against further depreciation. No one can doubt that when stable conditions again return, a turn of the market may be expected. As regards the position of the light castings foundries the demand for the principal article, cast-iron stove grates, has completely ceased. The prospects for the next six months are very gloomy. The purchasing power of small buyers has suffered considerably in view of the enormous increase in prices.

The good employment during last quarter did not, however, lead to a full exploitation of the capacity of the iron foundries owing to the general shortage of raw materials, particularly of coke and pig-iron. Complaints are general regarding the insufficient coke supplies. The large purchases of foreign fuel, which, owing to the depreciation of the mark, had to be limited, could not make good this deficiency. From sheer necessity not only English coke is being bought, but also so-called French exchange coke, which is 15 per cent. dearer than German coke. In the same way large quantities of foreign pig-iron were used, chiefly Luxemburg pig-iron, English hematite and Czech pig-iron. Furthermore, large quantities of German pig-iron smelted with English coke were bought. As regards raw material prices, it suffices to point out that the price for hematite and Nos. 1 and 3 foundry pig-iron have increased by 500 per cent., and for coke by 350 per cent. since October 1.

The fall of the foreign exchange in the middle of December led to a reduction of the pig-iron prices, when the Association of German Iron Foundries accordingly reduced their prices for the last quarter of the month of December. Even should the mark not depreciate, however, raw materials produced in Germany must increase in consequence of further increases in wages. Price increases must in the end have the result of reaching or even surpassing the world market prices.

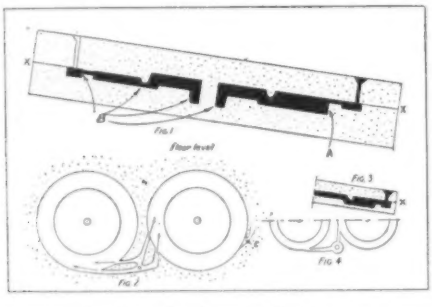
XUM

A Brass Foundry Waster.

The splitting of the casting shown in the photograph illustrating the foundry query on page 13 of January 4 issue of THE FOUNDRY TRADE JOURNAL, may have more than one cause. For instance, sluggish metal, improper casting, insufficiently vented mould, hard ramming, incorrect gating and too much moisture in sand, all tend to produce the defect shown.

I would strongly advise that the form of gate used should be altered by replacing the single gate by two small sprues placed or cut in such a manner that the metal is forced to the right of the two castings, causing a revolving or swirling motion around the mould until pouring or casting is finished. The form of the single ingate shown tends to become dangerous, where metal, during the filling of a mould, has to fall into interstices or meet projecting parts, as is the case with these castings.

When the boxes are placed on the ground floor it is far better to have them slightly inclined; but it should be understood that the lowest point of incline is at the gate end, and not the reverse. If a box is cast in the reverse sense, it is noticed that as soon as the metal enters the ingate, it is forced to the lowest point of the mound, awaiting to be connected up again with the next stream of incoming metal. Should the first portion become somewhat chilled, it is lifted with the further filling of the mould, and floats on the top, becoming only partially dissolved until pouring ceases. This chilled metal is held by pressure to the topmost part of the mould, which almost instantly becomes set. It is said that just before freezing takes place, gases are given off, and probably these castings fail to reach the porous sand or top of mould, on account of the solid metal. Around these chilled parts the usual functions of gas expulsion are taking place, but the gas is prevented from extracting itself from underneath the chilled portions, producing a cavity.



Skin drying should not be necessary if the pattern is in good order. However, if the pattern is rough, swelling or watering of mould will be necessary to mend any bad draw, and, as is very often the case, too much water is used. Skin-drying a mould that has been mended, or contains too much moisture in its sand, is of little use as a preventive against defective castings.

Trouble is sure to arise from the interior of the mould, as it receives little or none of the heat required to drive out the excess moisture. On further cooling of the mould, steam from the surrounding parts becomes condensed on the cooler parts, taking up moisture until all is cold.

A good, strong sand should be used, well vented, evenly and not too hard rammed, and, lastly, not too moist. Flour, French chalk, or plumbago can be dusted on face of mould.

Casting Temperature.

It is preferable to pour on the hot side. From experience in the melting and casting from non-ferrous scrap I have found to err on the high side proved more successful than the low. From experience one gains knowledge of handling scrap brass to such an extent that it is possible to sort out pieces suitable for the class of work in hand; thus one is able to use some judgment as to what temperature is suitable for running of the castings from the scrap chosen.

These remarks are no doubt, very crude, and based on rule of thumb; but still, they must be adhered to until we are able to employ pyrometers. And not till then shall we be able to have complete control over the many difficulties associated with the non-ferrous trade.

If a deoxidant has not been used, I would advise that 2 to 4 ozs. of 15 per cent. phosphor-copper should be stirred into 100 lbs. of mixture before taking from the furnace, and the metal cast on the hot side. When pouring, it is a good rule to ascertain that there is a proper lip on the crucible. If not, rub the pot with a bar so as to form a good outlet for the metal. The assuring of a quick, steady and unbroken stream of metal until the mould is full is an essential.

Back Pressure.

From the rising seen on the head during setting, it must be admitted that some gas pressure must have taken place, if we bear in mind the results of the defects. There are other considerations, but without further information I will not venture an opinion.

In Fig. 1, which shows box or mould on incline, *A* explains roughly the effect of a given quantity of metal poured into the mould through the unbroken flow of metal during the filling of the mould and also pressure produced at that point; whilst *B* should readily explain the rush of metal to the lowest part of the mould, and the elimination of the danger of cold metal being unable to redissolve satisfactorily before mould is cast. The air would be forced through the runner instead of the sand during casting. These castings should be poured quickly. This is almost impossible if the box is inclined the wrong way.

In Fig. 2, which shows the two proposed spray gates, the flow of metal is shown by the arrows. *C* indicates how the ingates should be filleted close to the casting, so as not to impede the flow of the metal at the immediate entrance into the mould.

Figs. 3 and 4 depict the correct way of single gating, if preference is given for its use. If "C. O. R." will take these hints seriously and put in practice as far as circumstances and conditions allow, I feel quite confident that his difficulties in the production of sound castings will be eliminated.

G. C. S.

Long Stops in Blast-furnace Working without Blowing Out.—An interesting experiment has just been made at the works of the Société Cockerill by the re-starting of a blast furnace after a shut-down of eighteen months. The only preparation for re-starting this furnace was reduction—by one-fifth—of the ore charge; no coke was added to the burden. The ease with which the furnace was again put into operation amply justifies the method which had been advocated for several years by the Cockerill concern, but could not be tried hitherto after a prolonged shut-down. It is a well-known fact that the chief difficulty when temporarily closing down a blast furnace is to guard against the ingress of air. The heat of the burden keeps up a draft resulting in air leaking in at joints and invisible fissures which consumes the coke and creates difficulties when re-starting. If when stopping a furnace its connection with a gas main in service is maintained by the downcomer, combustion can be effectually arrested. The pressure in the gas main will keep out air. This method can be easily carried out when there are several furnaces, for it is seldom that all of them are shut down at the same time, so that those remaining in blast will furnish the necessary gas pressure. To avoid gas losses by leakage it is necessary to plug the tuyeres of the idle furnace and to lute up all joints and leaks, just as would be done for a temporary stoppage. The pressure in the gas main is very slight, and combustion is soon stopped and the furnace rapidly cools down and all draft is stopped. There is no glowing coke left at all, and if hot blast—800 deg. C. or more—is available, it will be sufficient to relight the furnace. Where there is no sufficiently hot blast available, the furnace can readily be re-lit with shavings and wood put through the tap and slag holes. The Cockerill furnace under consideration, after being shut down as said for eighteen months, was tapped six hours after re-starting; both the pig-iron and slag were normal. It was, however, necessary to make a fresh tapping hole 75 cm. (30 in.) higher up, as the level of the old tapping hole was not reached till 48 hours after re-starting.

Volume Changes of Cast Iron on Solidification.*

By Oliver Smalley, M.I.Brit.F., Close Foundry, Gateshead-on-Tyne.

(Illustrations not appearing in the text will be found on pages 93 to 96.)

This Paper presents a series of experiments conducted on the volume change of various cast irons on solidification as related to piping or drawing.

It is a subject that has attracted recent attention, but under the more practical heading of "The Manufacture of Castings without Risers or Feeding." From the Papers, the common foundry contradictions appear of one man succeeding where another fails. None of the investigators touches the fundamental principles of their problem, but regard liquid shrinkage from the point of view of "rate of pouring."

In this Paper it is proposed to consider the three principal factors controlling liquid shrinkage, viz.:—(1) Pouring temperature; (2) rate of solidification; (3) chemical composition.

To measure quantitatively the volume or density changes of cast iron during solidification is a problem of some difficulty. The works of Keep of America and Turner and his collaborators of this country must be included in any representative anthology of contemporary research, their investigations having thrown considerable light on the function of each of the various chemical elements in cast iron. Rosenberg, "Stahl und Eisen," 1911, 31, 1408-1413, gives details of two sets of calculations on the volume relationship of a grey iron and a white iron in the liquid state, at 1,000 deg. C.—just after solidification—and at 0 deg. C. The results of his calculations are summarised in Table I., the figures representing the specific gravity under the conditions given.

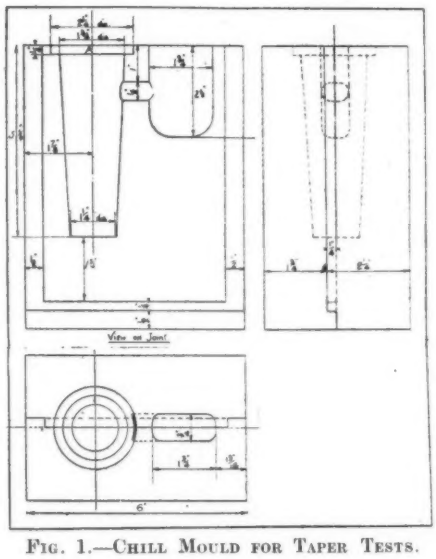


FIG. 1.—CHILL MOULD FOR TAPER TESTS.

TABLE I.—*Specific Gravity of Cast-Iron under various conditions.*

	Grey iron.		White iron.		Pig-iron, containing	
	1.	2.	1.	2.	3% Gr. 1% C.C.	1% Gr. 2% C.C.
Liquid ..	6.89	6.89	6.89	6.89	7.1	7.1
1,000° C. ..	6.75	6.46	7.22	6.91	6.9	7.2
0° C. ..	7.10	7.10	7.60	7.60	7.2	7.4

The values for the grey iron and the white iron were obtained from published data on the specific gravity of solid and molten pig-iron, and on the coefficient of linear expansion, the latter being taken as 0.0000175 for the figures in Col. 1 and as 0.000033 for those in Col. 2. The figures in the last two columns of the table were obtained by calculation based on the relative densities of pure iron, iron carbide and graphite, and the separation of the graphite from the carbide during solidification.

Having regard to the various factors omitted in this brief investigation, owing to lack of available data, the results obtained by the two methods of calculation agree satisfactorily. In the case of white iron, there is a diminution of volume on solidification, and in grey iron an increase, which advances in proportion with the grey character of the iron.

In this research it is intended to consider the volume changes of grey cast iron on solidification in a broad, practical sense, avoiding abstruse metallurgical discussions as far as possible. To obtain true quantitative data, it is necessary to adopt a constant degree of solidity throughout. Unfortunately, the property of solidity of a porous material such as grey cast iron is not easily expressed, let alone measured or controlled. There is certainly a close inter-relation with the graphite content and its form, but the control of these represent one of the foremost problems of cast iron. The pipe or liquid shrinkage of cast iron might readily be regarded as distributed in the form of minute cavities alongside with the graphite, apart from the graphite itself being considered as equivalent to so much space. The effect of the separation of the graphite on the volume changes is best conceived from its density, which, taken at 2.6, means that 3.0 per cent. of graphite in a grey iron occupies no less than 9.0 per cent. of the total volume of the iron. But apart from the fact that graphite in pig-iron is of the swelling type—as its density is a variable which is affected by the conditions of manufacture of the pig-iron in the blast furnace—and therefore the control of the quantity of graphite in cupola-melted iron is most disconcerting, due to the vagaries of such poignant factors as nature of the pig-iron, rate of melting, blast-pressure, coke to iron ratio, and quality of coke, etc.

Thus handicapped by our limited knowledge, this Paper can but touch the fringe of the scientific principles or liquid shrinkage. It was hoped, however, to be able to obtain comparative data on the effect of the aforementioned factors, viz., pouring temperature, rate of cooling, and chemical composition so far as their practical application was concerned.

Of the respective merits and demerits of the various methods adopted in the early stages of this work, that of casting a cone from the top with the wide end up seemed to offer the greatest promise, provided the mould could be filled almost instantaneously, and the hottest metal retained at the top. Even with such conditions, it was felt that a plastic material such as cast iron, whose freezing range may vary from a few degrees to 300 deg. C., this property of plasticity must receive due consideration in regard to its relation to rate of pouring, if one is to investigate successfully any of the factors outlined.

M. Ronceray, in a series of practical experiments, has emphasised the great possibilities by controlling the rate of pouring, and the author feels that he could not do better than supplement M. Ronceray's experiences by conducting a separate investigation with various grades of cast iron, possessing different degrees of plasticity.

Form of Mould Used.

A cast-iron mould, machined to the dimensions shown by Fig. 1, was used in the first series of experiments. This contained two compartments, the one the test ingot, the other the pouring dish. The halves were clamped together by means of a strong steel screw clamp. Except where otherwise stated, the mould was used at 200 deg. F. (90 deg. C.).

Two operators were necessary, the one to pour the metal, the other to place a flat fireclay disc, which had been pre-heated to 600 deg. C., in the recess at A, in order to ensure a constant volume of metal, and to secure final solidification in the upper part of the ingot.

* A Paper presented to the Newcastle Branch of the Institution of British Foundrymen, Mr. H. J. Young in the chair.

For the determination of the piping effect in true alloys this apparatus has given useful quantitative information, the volume of the pipe being simply estimated. With cast iron, the problem is more complicated. In the first place, little or no piping was found with any of the grey irons, and, on sectioning through the middle, each was uniformly dense and solid. The top portions of these are shown by Figs. 2-12. Each was cast with 10 per cent. super-heat. No. 2, a hard iron, shows a trace of piping. No. 3, the same class, but slightly higher in P, shows a distinct expansion. Except for the P content, No. 4 is similar in composition to No. 3. If there is any coign of vantage between these two, No. 3 certainly shows a less shrinkage. No. 5 depicts the shrinkage of an ordinary cylinder iron, and No. 6 that of a Barrow hematite high in T.C. but low in S and P. A common grey iron, containing 2 per cent. Si and 0.90 per cent. P, is represented in Nos. 7 and 8, the former being cast in a mould preheated to a dull red heat, and the latter cast in a mould at 200 deg. F. Apart from the presence of blowholes common to cast iron, cast in hot chill-moulds, a depression in the top of the ingot is clearly

cooling without interfering with the rigidity of the mould.

The *modus operandi* was also similar, placing a loam cake preheated to 600 deg. C. in the recess shown at the top of the mould, so as to obtain a sharply-defined pipe or draw in the centre of the top of the casting.

Figs. A and B represent a 70/30 and a 60/40 brass made in this mould. These not only illustrate the clearly-marked depression due to liquid shrinkage, but afford a comparison with that of cast iron.

Liquid Shrinkage of Cast Iron.

The common defects of casting grey iron cold are short runs, shots and blowholes, low strength, cracks and shrink cavities. The last-mentioned defect is one most foundrymen have encountered. It is aggravated by the numerous anomalies of cast iron, and is eloquent of the importance of control of casting temperature more accurately than by the vapid expression of terms, hot and cold. In molten cast iron there exists a temperature balance reaction with the constituents present and the dissolved gas. The technology of this balance

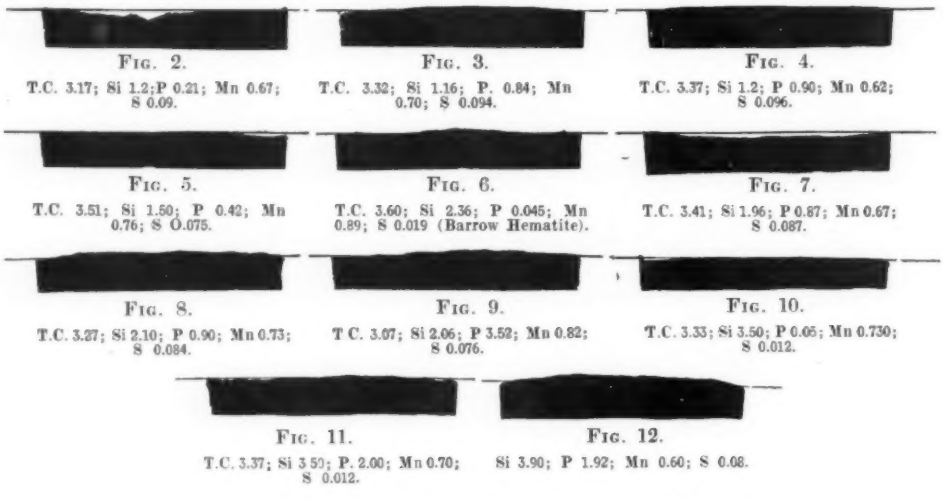


FIG. 2.
T.C. 3.17; Si 1.2; P 0.21; Mn 0.67; S 0.09.

FIG. 3.
T.C. 3.32; Si 1.16; P. 0.84; Mn 0.70; S 0.094.

FIG. 4.
T.C. 3.37; Si 1.2; P 0.90; Mn 0.62; S 0.096.

FIG. 5.
T.C. 3.51; Si 1.50; P 0.42; Mn 0.76; S 0.075.

FIG. 6.
T.C. 3.60; Si 2.36; P 0.045; Mn 0.89; S 0.019 (Barrow Hematite).

FIG. 7.
T.C. 3.41; Si 1.96; P 0.87; Mn 0.67; S 0.087.

FIG. 8.
T.C. 3.27; Si 2.10; P 0.90; Mn 0.73; S 0.084.

FIG. 9.
T C. 3.07; Si 2.06; P 3.52; Mn 0.82; S 0.076.

FIG. 10.
T.C. 3.33; Si 3.50; P 0.05; Mn 0.730; S 0.012.

FIG. 11.
T.C. 3.37; Si 3.50; P. 2.00; Mn 0.70; S 0.012.

FIG. 12.
Si 3.90; P 1.92; Mn 0.60; S 0.08.

MOULD TEMPERATURE IN EVERY CASE 200 DEG. F., WITH THE EXCEPTION OF FIG. 7, WHICH IS 1,000 DEG. F.

shown, whilst a slight elevation is revealed in No. 8. Retaining the silicon constant at 2 per cent., but increasing the P to 3.5 per cent., does not appear to exert any effect. No. 10 shows the shrinkage of a hematite iron containing 3.5 per cent. Si. The slightest elevation is observable. By the addition of 2 per cent. P, no change was apparent, but if there was any difference at all, the phosphoric iron displayed a less expansion than the non-phosphoric iron. Increasing the Si to 3.9 per cent., the phosphoric iron showed a distinct elevation.

These experiments, though conducted under laboratory conditions with meticulous care, but emphasise the complexities involved in the determination of volume changes of cast iron on passing from the liquid to the solid state. They also indicate the possibility of casting any grey cast iron without drawing, provided that the metal is poured with the correct degree of super-heat and the rate of solidification is sufficiently rapid. As the experiments proceeded, the results became increasingly difficult to coincide with orthodox views, and whilst it was felt very desirable to obtain absolute data, the many variables encountered defied anything more than general observations, and which could not be applied easily to sand castings.

Sand Castings.

For this reason the mould shown in Fig. 13 was used. In principle, this is similar to the permanent mould, Fig. 1, except that, being constructed in sand, one could investigate the effect of rate of

is not clear. By varying the pouring temperature, one may not only change the liquid shrinkage, but produce or eliminate blowholes at will. To exemplify: Three small castings of the form shown by Fig. 14 were made in cylinder iron, analysing C 3.03, Si 1.35, Mn 0.90, P 0.87, and S 0.060 per cent., pouring the first hot, *i.e.*, at 1,330 deg. C., the second on the cold side, about 1,280 deg. C., and the last when the metal was decidedly dull. The first casting was clean and solid, the second presented a few minute blowholes, and a rough skin in upper portions, but the third was badly blown and dirty; it was also drawn in the top face. Sulphur prints, Figs. 15, 16, and 17, taken from a section of each, illustrate the nature of the defects, and show that the chemical reaction responsible for the gas holes is accompanied by a change in the form of the sulphur compounds. This is one of the best methods for ascertaining the pouring temperature of defective casting.

Casting Temperature.

To enable a better understanding and promote a more concise expression of casting temperature, the temperature of incipient and final solidification of the irons commonly made in the cupola have been determined. These are detailed in Table II.

By the addition of a specified degree of superheat the desired pouring temperature for any grade of iron or casting is obtained.

Figs. Nos. 18 and 19 represent a hard cylinder iron cast at 1,330 and 1,260 deg. C. in

a hard sand mould. The former exhibits a distinct draw or pipe central at the top, No. 19 a similar draw which is accompanied by a secondary pipe. The change in the form of the sulphur compounds and in structure of the last portions to freeze are also clearly portrayed. Further illustrations referring to the effect of temperature will be submitted in conjunction with pouring rate.

Effect of Rate of Solidification on Liquid Shrinkage.

A hard rammed sand and a chill lined sand mould were used to investigate the effect of rate of cooling, except where otherwise stated. Each mould was preheated to 100 deg. F. (37 deg. C.) and run at the same time from the same ladle of metal with 8 to 10 per cent. superheat. The irons investigated were of the composition shown in Table III:—

TABLE II.—*Freezing Temperatures of Various Irons.*

Mark.	Total carbon.	Silicon.	Mang.	Phos.	Sulphur.	Incipient solidification °C.	Main solidification °C.	Phosphide solidification °C.
1	3.40	1.03	0.63	0.09	0.063	1,243	1,160	960
2	3.27	1.15	0.62	1.54	0.086	1,221	1,125	957
3	2.88	1.27	0.55	0.47	0.096	1,232	1,153	955
4	3.11	1.50	0.71	0.52	0.097	1,210	1,142	955
Coe. ..	2.71	2.01	—	0.09	—	1,212	1,148	—
5	3.38	2.30	0.60	0.78	0.063	1,165	1,149	956
6	3.12	2.49	0.52	1.28	0.050	1,160	1,132	960

TABLE III.—*Composition of Irons used to determine the Effect of Rate of Shrinkage on Liquid Contraction.*

	T.C.	Si.	Mn.	P.	S.
Hard cylinder ..	3.22	1.18	0.73	0.34	0.112
Ord. ,, ..	3.22	1.55	0.66	0.65	0.097
Common grey ..	3.20	2.20	0.60	0.80	0.086

Hard Cylinder Iron is portrayed by Figs. 20 and 21, representing the sand and chill casts respectively.

Ordinary Cylinder Iron by Figs. 22 and 23.

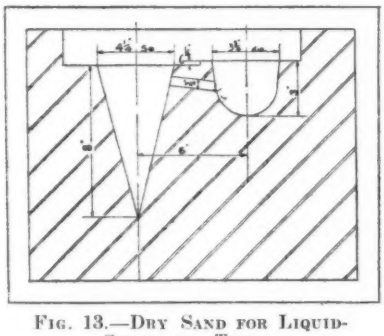


FIG. 13.—DRY SAND FOR LIQUID-SHRINKAGE TESTS.

Common Grey Iron.—In this instance two chill moulds were used, the one preheated at 1,100 deg. F. (590 deg. C.) and the other to 100 deg. F., represented by Figs. 24 and 25 respectively. The former shows a few subcutaneous blowholes common to hot metal poured into hot moulds; also it exhibits a contraction cavity common to castings when slowly cooled. This series of experiments confirm the findings of the exploratory casts made in the permanent mould, *viz.*, the more rapid the cooling the less the liquid shrinkage of grey cast iron, and that within a certain limited critical rate of cooling, hard cylinder, ordinary cylinder and common grey iron exhibit little or no volume change on solidification so far as piping is concerned.

This implies that there exists for each grade of cast iron a minimum rate of cooling within which grey cast iron does not shrink on solidification when poured at a suitable temperature, and that a soft grey iron cooled more slowly than this permitted critical cooling rate, will pipe just as readily as the harder iron. This point will be returned to again under the heading of "Casting Without Feeding Risers."

Effect of Chemical Composition on the Volume Changes of Solidification.

In considering drawing and shrinkage cavities in cast iron, one must differentiate between the cavities due to liquid shrinkage and those that may be attributed to liquid expansion. It is this discrimination that renders the problem of "Feeding" so confusing. To exemplify:—A 6-in. cast-iron cube poured from the bottom with the metal on the dull side in a dry sand mould will present a sink hole in the top, due to liquid shrinkage, and a draw-hole in the centre of the block, due to an entirely different cause. Any grey iron cooled during solidification slower than a "minimum critical rate" presents these shrinkage flaws, which can only be completely eliminated by speeding up solidification. The common belief was that chilling did not remove such draws, but only transferred them to places where they were not noticeable. That such a view is erroneous may be demonstrated by casting, say, two 8-in. sq. blocks from the bottom without risers, the one in a sand mould and the other in a permanent mould. The former invariably exhibits a large draw in the centre about 1/3 from the top, whilst the latter will be uniformly solid throughout. The explanation commonly accepted for the cause of this somewhat abnormal phenomenon is that the rigidity of the permanent mould reverses the direction of natural expansion of the iron, a point to which reference will again be made.

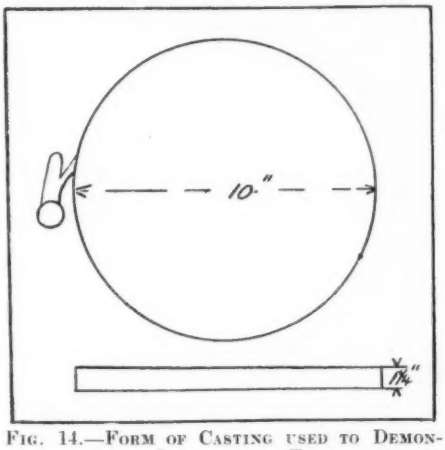


FIG. 14.—FORM OF CASTING USED TO DEMONSTRATE THE INFLUENCE OF TEMPERATURE ON SOLIDITY.

To obtain comparative data on the effect of chemical compositions it was decided in the first series of experiments to use chill moulds, which would have the same amount of "give" to the expansion of the metal.

This was achieved by means of a chill-lined sand mould, ramming each box with the same sand under identical conditions as far as possible. Pouring temperature was fixed at 10 per cent. superheat.

Influence of Carbon.

Figs. Nos. 26 and 27 show the effect of a varying carbon content on a low phosphorus grey iron containing 2 per cent. silicon, although there is also a slight variation in the sulphur contents. The former possessing a high total carbon content, 3.76 per cent., presents a convex surface, indicative of liquid expansion, and the latter containing 2.95 per cent. total carbon inclines to a concave surface, indicative of liquid contraction.

Effect of a Varying Total Carbon and Silicon Content.

The etchings shown in Figs. 28, 26 and 29 represent three low phosphorus irons of the composition shown in Table IV.:—

TABLE IV.—*Compositions of Irons used to determine Effect of a Varying Total Carbon and Silicon Content.*

No.	T.C.	Si.	Mn.	P.	S.
28 ..	2.84	1.17	0.55	0.06	0.065
26 ..	3.76	1.92	0.70	0.06	0.022
29 ..	3.36	3.55	0.74	0.05	0.014

The base of each was Barrow hematite pig-iron. In the case of No. 28, a stock pig-iron of suitable chemical composition was first made from hematite and steel; No. 26 was made from all hematite; and No. 29 from hematite plus 25 per cent. Si, ferro silicon. One hundred lbs. of each pig were melted in a pot furnace, the temperature of pouring being controlled between 8 and 10 per cent. of superheat.

solidity of castings made in permanent moulds is that "the rigidity of the mould reverses the direction of the natural expansion on solidification," whilst sand moulds "give" to it. The chill and sand-cast made from the various irons used in this research do not substantiate this, for the actual rigidity of the main body of both moulds, which were of similar dimension and rammed up from the same heap of sand by the same man, were identical. Again, the cast shown in Fig. 24 was made in a red-hot chill-mould, and presents a distinct draw, whilst the cast shown in Fig. 25 was made in exactly the same type of mould, and cast at the same moment from the same ladle, does not present any draw.

To project the investigation of the rigidity of mould as related to drawing or piping, three sets of moulds were prepared, *viz.*, dry-sand, excessively hard-rammed milled-ganister, and a lightly-rammed green-sand containing 4.6 per cent. moisture. They vary considerably in rigidity, the ganister mould, after baking, being almost as

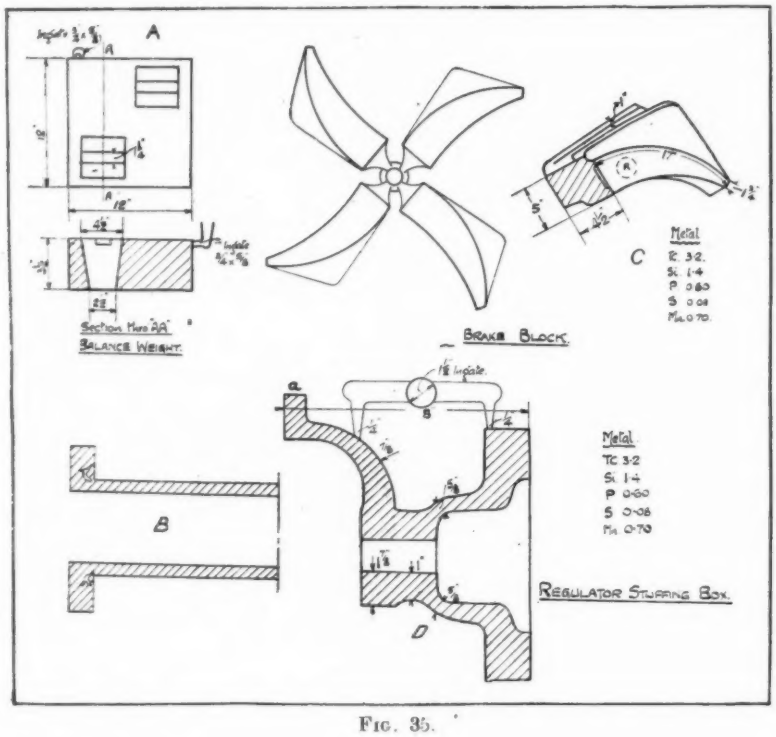


FIG. 35.

These experiments demonstrate the relative drawing of the extremes of the hard and soft non-phosphoric irons.

Phosphorus.

The etchings illustrated in Figs. 22 and 30 represent 1½ per cent. Si irons containing 0.60 and 2.36 per cent. respectively, cast in dry-sand moulds under similar conditions.

Figs. Nos. 27, 25 and 31 present three 2 per cent. Si grey irons of somewhat similar chemical composition, with the exception of a varying phosphorus content of 0.11, 0.80 and 2.85 per cent. respectively, cast in chill-lined sand-moulds at 100-110 deg. F.

The effect of 2.5 per cent. P on a 3.5 per cent. Si iron appeared to be negligible, and Fig. 29, when taken from an ordinary grey iron containing 3.5 per cent. Si and 0.05 per cent. phosphorus, suitably portrays an iron of similar chemical composition with the exception of 2.5 per cent. phosphorus.

These experiments have contributed an important element of interest in the fact that P exerts little or no effect on the actual liquid shrinkage of cast iron under the above-mentioned conditions when poured with a suitable degree of superheat.

Rigidity of Mould.

In an early prefatory note it is stated that the explanation commonly given and accepted for the rigid as iron, whilst the green-sand readily responded to a slight pressure of the finger.

The etchings reproduced in Figs. 32, 33 and 34 present three casts made from a common grey iron (T.C., 3.2; Si, 2.14; Mn, 0.82; So, 0.078; P, 0.92 per cent.) poured almost simultaneously with about 9 per cent. superheat from the same ladle of metal. They suggest that the rigidity of the mould does not enter into the question, although the ganister cast presents the greatest solidity in the centre. This, however, appears to be a question of heat-conductivity, the denser ganister extracting the heat more rapidly than the dry-sand or green-sand moulds. This experiment, therefore, was repeated, preheating the ganister mould to 300 deg. C. This confirmed expectations, and showed the hot ganister casting to have drawn rather more than the cast in green-sand, although the volume change is not strictly comparable on account of slower cooling permitting of a continued chemical change whilst in the mould.

These experiments, conducted with a soft grey iron, establish the fact that the rigidity of mould enters but little into the question of the drawing properties of cast iron. They suggest, however, that "the rigidity of the outer shell of the cast during solidification is an important factor to be reckoned with, and that the solidity of iron castings is related to the reversal of the first expansion of iron during solidification.

XUM

Volume Changes of Cast Iron on Solidification.

See Pages 89 *et seq.*

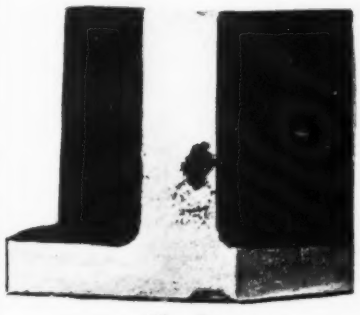


FIG. 39.

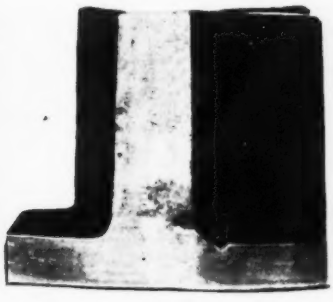


FIG. 40.

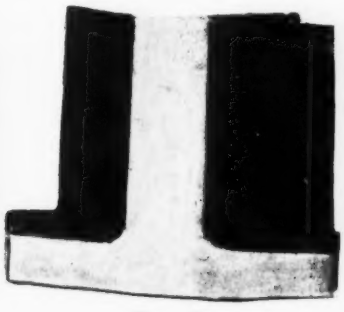
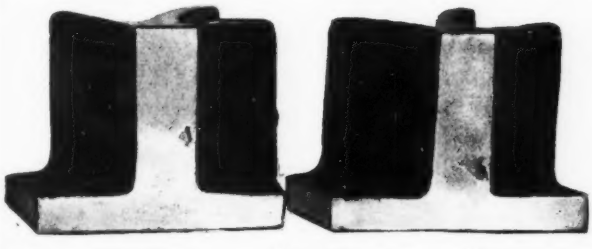


FIG. 41.



A. FIG. 61. B.

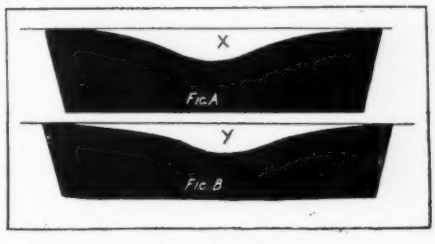


Fig. A shows the depression with 70/30 brass. Volume of X is 1.649 cub. ins. Fig. B is 60/40 brass, Y being 1.117 cub. ins. Both are cast in dry sand, the mould temperature being 90 deg. F.

FIG. 49.—DRY SAND.

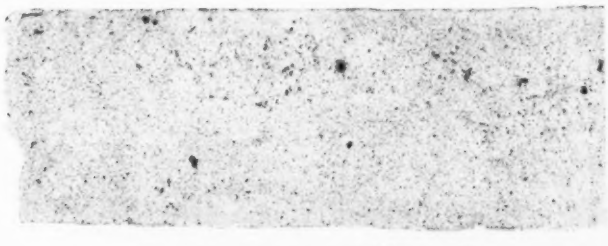


FIG. 15.—POURED AT 1,330 DEG. C.

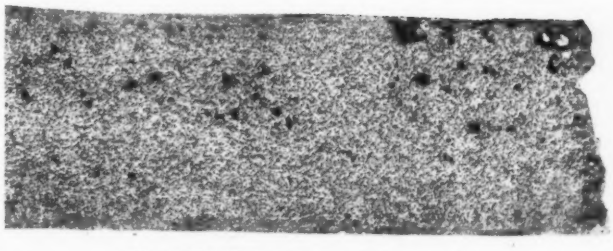


FIG. 16.—POURED AT 1,280 DEG. C.

FIG. 50.—GREEN SAND.

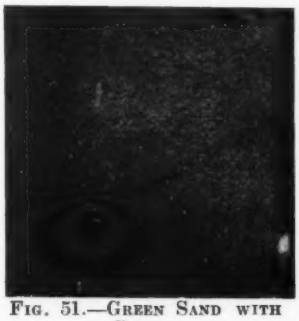


FIG. 51.—GREEN SAND WITH CHILLS.

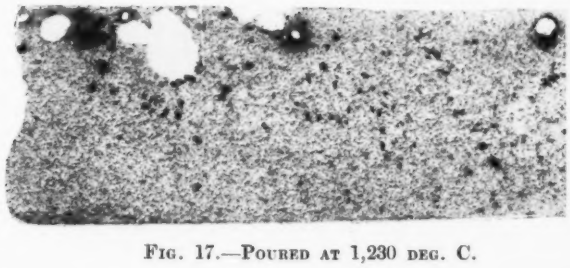


FIG. 17.—POURED AT 1,230 DEG. C.

Volume Changes of Cast Iron on Solidification.

See Pages 89 *et seq.*

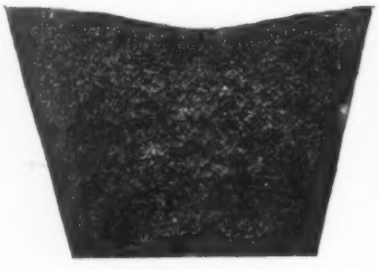


FIG. 18.

Hard Cylinder Iron cast hot in dry sand at 1,340 deg. C. Composition, T.C. 3.12; Si 1.18; Mn 0.70; P 0.039; S 0.098. Mould Temp., 100 deg. F.

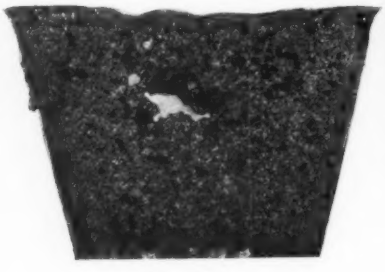


FIG. 19.

Same as Fig. 18, but cast cold at 1,260 deg. C. Composition, T.C. 3.05; Si 1.18; Mn 0.72; P 0.39; S 0.087.

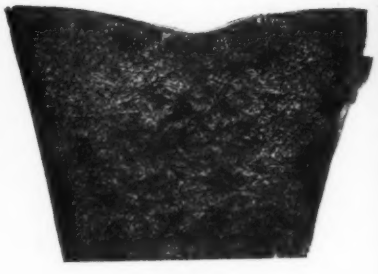


FIG. 20.

Same as Fig. 18. Cast at 1.335 deg. C. Composition, T.C. 3.25; Si 1.16; Mn 0.73; P 0.34; S 0.012.

FIG. 21

Hard Cylinder Iron, chill-cast at 1,335 deg. C. Composition, T.C. 3.22; Si 1.18; Mn 0.73; P 0.34; S 0.112.

FIG. 22.

Ordinary Cylinder Iron, cast in dry sand at 1.320 deg. C. Composition, T.C. 3.22; Si 1.55; Mn 0.60; P 0.63; S 0.096. Mould Temperature 120 deg. F.

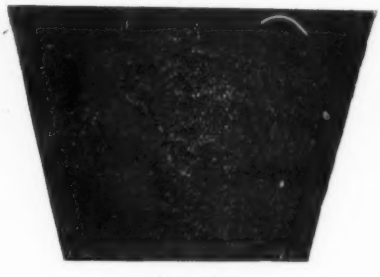


FIG. 23.

Same as Fig. 22, but chill-cast at 1,320 deg. C. from the same ladle. Mould Temperature, 130 deg. F.

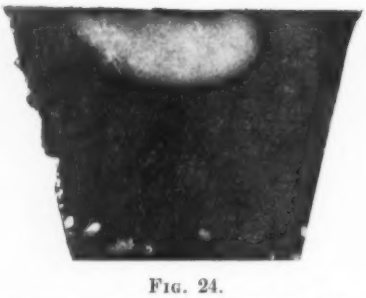


FIG. 24.

Common Grey Iron. Cast at 1,270 deg. C. in a hot chill (1,100 deg. F.). Composition, Si 2.12; Mn 0.62; P 0.81; Si 0.085.

FIG. 25.

Common Grey Iron, chill cast at 1,270 deg.C. Composition, Si 2.12; Mn 0.60; P 0.80; S 0.086.

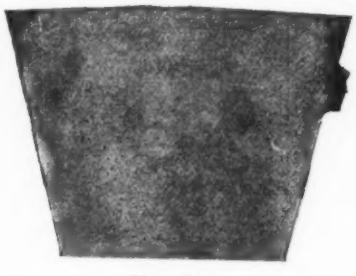


FIG. 26.

Chill cast at 1.275 deg. C. Composition, T.C. 3.76; Si 1.92; Mn 0.70; P 0.06; S 0.022. Mould Temperature, 110 deg. F.

FIG. 27.

Chill cast at 1,295 deg. C. Composition, T.C. 2.95; Si 2.10; Mn 0.64; P 0.11; S 0.088.

FIG. 28.

Chill cast at 1,355 deg. C. Composition, T.C. 2.84; Si 1.17; Mn 0.55; P 0.06; S 0.065.

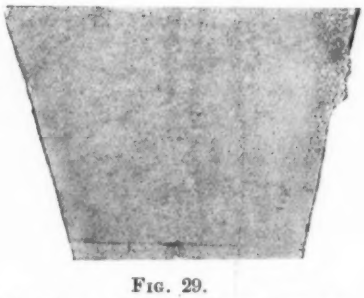
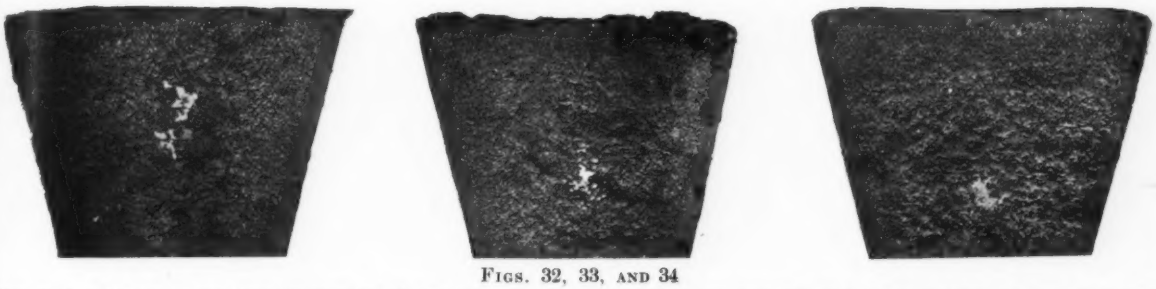


FIG. 29.

Chill cast at 1,240 deg. C. Composition, T.C. 3.36; Si 3.55; Mn 0.74; P. 0.04; S. 0.014.

Volume Changes of Cast Iron on Solidification.

See Pages 89 *et seq.*



FIGS. 32, 33, AND 34

Figs. 32, 33 and 34 are all cast from the same iron at 1,310 deg. C., but Fig. 32 is cast in dry sand, Fig. 33 in baked ganister, and Fig. 34 in green sand. The composition is T.C. 3.21; Si 2.14; Mn 0.82; P 0.92; S 0.078.

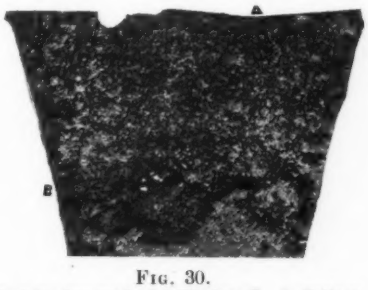


FIG. 30.
Cast in dry sand at 1,273 deg. C. A distinct contraction is shown at A, and an open, spongy area about 1 sq. in. at B.

FIG. 31.
Chill cast at 1,260 deg. C. Composition, T.C. 2.86; Si 1.90; Mn 0.46; P 2.85; S 0.089.

FIG. 59.
T.C. 2.65; Si 0.89; Mn 0.56; P 0.18; S 0.15.

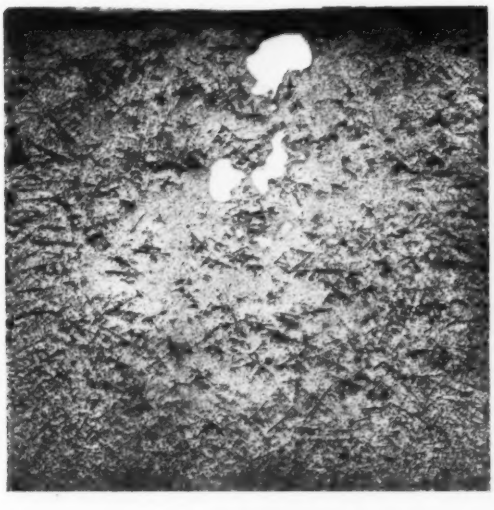


FIG. 60.
T.C. 3.0; Si 2.22; Mn 0.82; P 0.87; S 0.064.

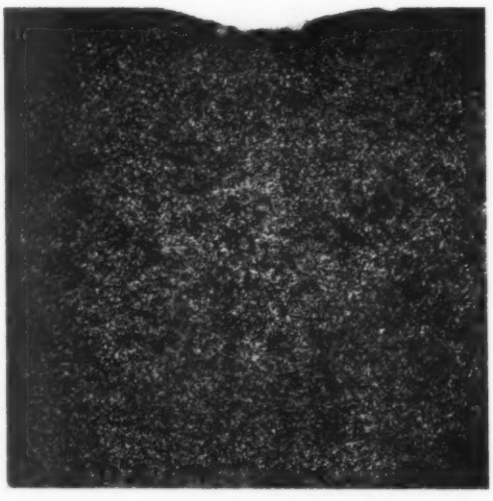
FIG. 42.
Soft Grey Iron.

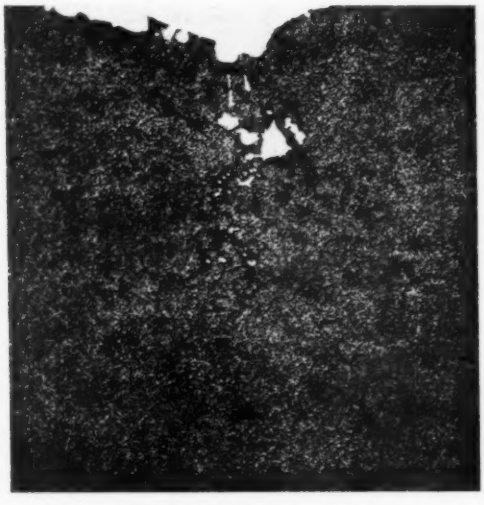
FIG. 43.
Harder Grey Iron.

FIG. 44.
Hard Cylinder Iron.

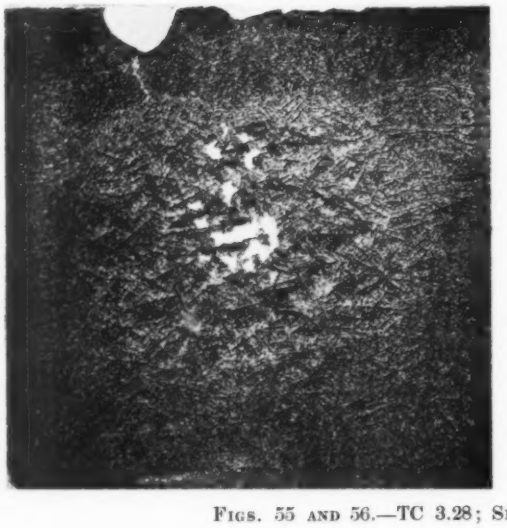
Volume Changes of Cast Iron on Solidification.

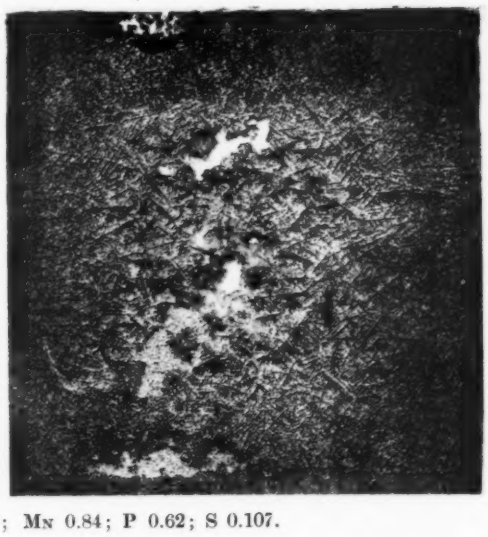
See Pages 89 *et seq.*



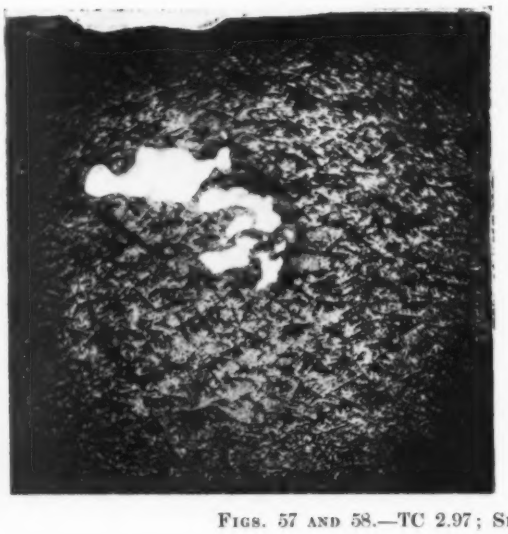


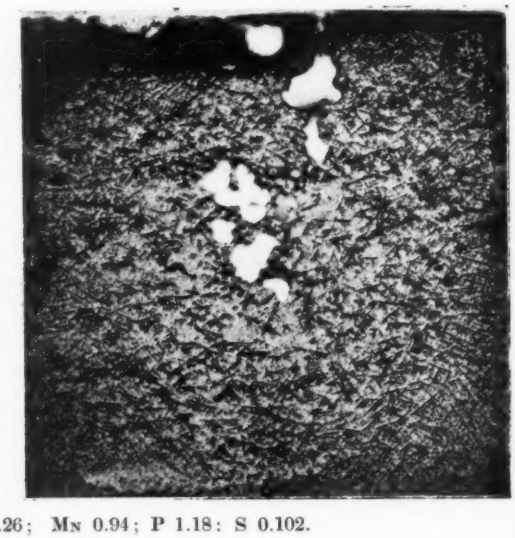
Figs. 53 and 54.—TC 2.89; Si 1.14; Mn 0.67; P 0.18; S 0.131.





Figs. 55 and 56.—TC 3.28; Si 1.64; Mn 0.84; P 0.62; S 0.107.





Figs. 57 and 58.—TC 2.97; Si 3.26; Mn 0.94; P 1.18; S 0.102.

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CASTING WITHOUT RISERS OR FEEDING.

Practical Interpretation.

To demonstrate the practical application of the foregoing research in the economic production of castings some simple forms common to certain types will be considered.

Composition *v.* Piping or Drawing.

Within reasonable practical limits, the composition of grey cast iron is secondary in the question of liquid shrinkage, a soft grey iron drawing to the same degree as a hard grey iron. This implies that a casting which can be made in the softer iron without feeding may be produced equally well in a harder iron, and of the two, the harder will yield the more solid casting.

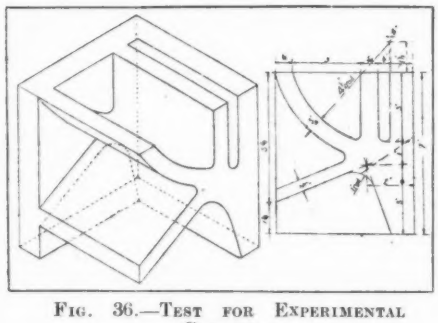

FIG. 36.—TEST FOR EXPERIMENTAL CASTINGS.

Three types of castings will be considered. They are shown at "A," "B," and "C," Fig. 35. "A" is a simple cored block. It was originally made in grey iron (T.C., 3.2; Si, 2.2; P, 1.0; Mn, 0.7; and S, 0.08 per cent.), with one riser 2½ in., tapering to 7 in. By dispensing with the riser this casting was successful, provided hot metal was used. When fractured, they presented an open texture in the centre. Casting in a harder iron (T.C., 3.0; Si, 1.5; Mn, 0.7; P, 0.6; and S. 0.08 per cent.) in exactly the same way at a good temperature, the blocks were uniformly solid throughout.

The pipes, of which "B" is an example, exhibited a draw as shown, when made in a soft grey iron. To obviate this, chills were resorted to. By substituting the soft iron for a hard iron containing 1.6 Si, 0.6 P, 0.7 Mn, and under 0.1 per cent. S, the defect was eliminated, and both chills and risers dispensed with.

Brake blocks of the type shown at "C," Fig. 35, were machine-moulded, four in a box, using a 2½-in. riser tapering to 6 in. in the middle of the heavy section of each. Despite this precaution, defects appeared under the riser in the form of a draw when made from either a soft or a hard

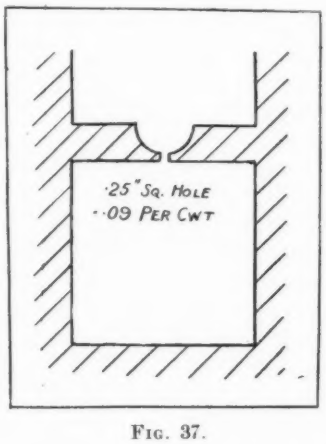

FIG. 37.

iron unless given special care. Using a hard metal containing from 1.3 to 1.4 per cent. Si, 0.7 Mn, 0.6 P, and under 0.1 per cent. S, and casting with over 8 per cent. superheat in the same way, but dispensing with risers, ensured solid castings.

Composition *v.* Solidity.

To demonstrate more clearly the effect of composition on solidity, three castings will be considered, Figs. 36, 37, 38. Fig. 36 represents a section commonly encountered in cylinder castings, and is one of the most complicated sections with which the foundryman has to cope; Fig. 37 a simple 6 in. block; and Fig. 38 represents a sluice valve.

The casting represented by Fig. 36 was purposely cast in the manner shown, with the thinner sections on the top, and afterwards sectioning each casting through the position of "drawing" according to the isothermal lines.

Figs. 39, 40 and 41 represent a soft grey iron, a harder grey iron, and a hard cylinder iron respectively. Each was cast with the same degree of superheat, head of metal and initial temperature of mould, to eliminate as far as possible all variables except chemical composition.

Figs. 42, 43 and 44 represent the same iron cast into 6-in. cubes under identical conditions. They definitely establish the "drawing" common to ordinary soft grey iron, and the solidity of the

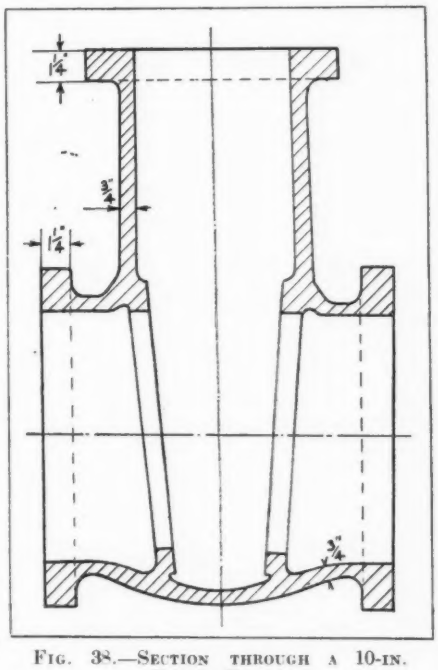

FIG. 38.—SECTION THROUGH A 10-IN. SLUICE VALVE.

harder iron. These results fully confirm anticipations, and project the order of importance of selection of iron so far as its chemical composition is concerned.

Sluice Valves.

At one time it was customary to cast sluice valves (Fig. 38) in a common grey iron, using risers on the flanges. Trouble was encountered from leaking under water-test at the valve faces which necessitated the use of chills. From the foregoing experiments on solidity, however, the use of an iron containing T.C., 3.0; Si, 1.3; Mn, 0.7; P, 0.2 to 0.30; and S, under 0.10 per cent., suggested the possibility of manufacture without the aid of either risers or chills.

To try out this, 20 castings were made. These proved successful, and large numbers have since been cast without exhibiting any trace of porosity.

These examples illustrate the practical application of the foregoing tests so far as "drawing" and "solidity" is concerned. It must be remembered, however, that although the harder irons have been demonstrated to exhibit, under certain conditions, the same liquid shrinkage as the softer grades, their superior solidity by no means justifies a general adoption. Their use is strictly limited to certain special castings where solidity of section and the particular mechanical properties accompanying such irons are essential, and even in the production of such castings, the disregard of any

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of the precautions outlined will find the foundryman confronted with defects, such as dirty faces, blowholes, poor finish and the like; defects which more than counter-balance any advantage gained in solidity. The harder the cast iron the higher the temperature of solidification. Casting, therefore, must be performed at a correspondingly higher temperature; it is not sufficient to cast at the temperature suitable for soft iron, or drawn defective castings will result.

Rate of Cooling.

Cupola-melted grey cast iron, of normal chemical composition, does not shrink on solidification, if poured with a sufficient degree of superheat and if cooled faster than a certain critical rate.

To authenticate this statement in its practical application to the manufacture of castings, a small bedplate of light section, with heavy bosses attached (Fig. 45), and a simple block of cast iron will be considered.

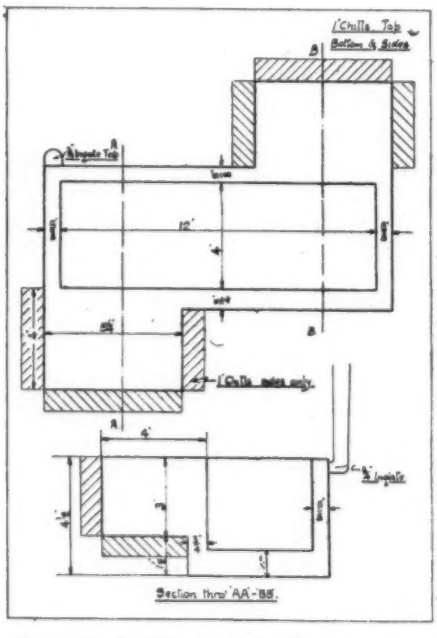


FIG. 45.—LIGHT-SECTIONED BEDPLATE WITH HEAVY BOSSES.

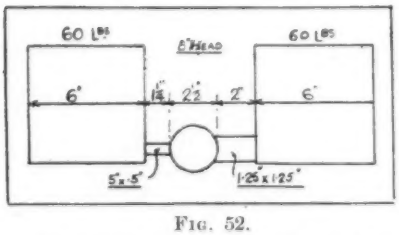


FIG. 52.

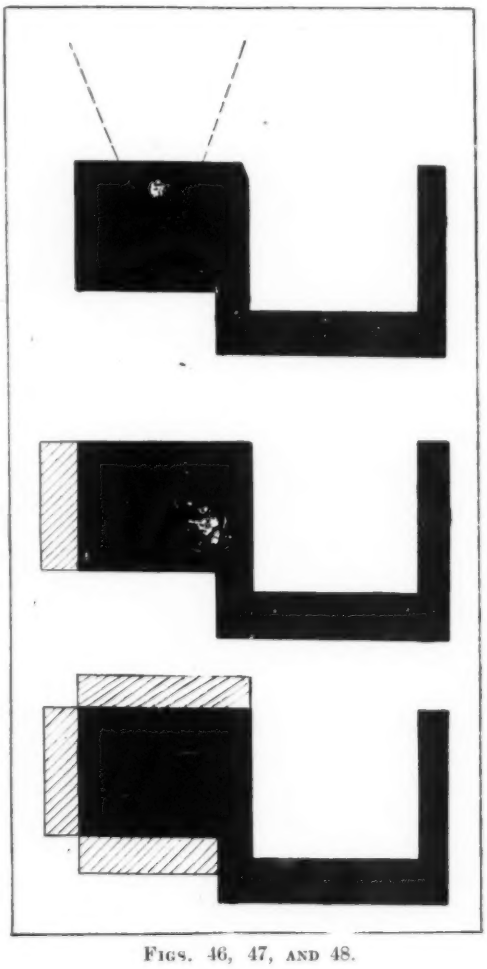
Mould prepared for ascertaining the Rate of Flow in Mass Experiments. The Ratio of the large runners to the small runners is as 2.9 sq. in. per cwt. is to 0.46 sq. in. per cwt.

Fig. 46, representing section A-A, indicates the drawing, when cast with feeding risers, 2¼ in. tapering to 7 in. on the boss, Fig. 47 is the same section, when cast without risers, using three 1-in. chills on the sides, as shown, and Fig. 48 is, when cast with chills at the sides, top and bottom.

These illustrations are self-explanatory of the best methods of economic production and illustrate the principles involved in the manufacture of castings of this nature, where troubles, due to draw and the like, are commonly encountered. When the change in section is so drastic, as that shown in this instance, care must be taken to adjust the extraction of heat so that the heavy and light sections cool at the same rate. Figs. 49, 50 and 51, represent 6-in. cubes, cast in dry-sand, in green-sand, and in a green-sand mould lined with 1-in. chills.

Rate of Pouring *v.* Solidity.

The ideal method of casting a block of metal sound with minimum of head, is to fill the mould gradually from the top at such a rate that there is uniform solidification throughout. Without a knowledge of the freezing range of temperature, or of the physical laws governing solidification, mass effect, pouring temperature and rate of extraction of heat by the mould, certain practical adjustments must be made according to the operators' experience under similar conditions. Consider the common form of ingot. In brass, manipulative skill often suffices, and the production of sound ingots presents little or no difficulty to the experienced caster. So far as steel is concerned, the ratio between the rate of filling the ingot mould, and the size of the ingot, is determined in some works and tabulated in detail, but since this is affected by both the nature of the steel, and the temperature at which poured, the



FIGS. 46, 47, AND 48.

calculation must fall short to an amount determined by the extent to which these variables operate.

If the casting of a simple form such as an ingot, in a material which has received more scientific attention than any other alloy, is so uncertain, how can one expect a general formula for the dimensions of ingates, such as that suggested by Mons. Ronceray, suffice for any form of casting in such a complex substance as cast iron.

To demonstrate the effect of rate of pouring on solidity, and to illustrate some of the complications involved, a series of 6-in. cubes, cast from three grades of metal, will be considered.

Bottom Pouring.

In the first series the cubes were moulded in pairs in one box, running one quickly and the other slowly from the bottom by means of a common down-gate, as shown by Fig. 52. The

dimensions of the ingates were 1½ in. sq., *i.e.*, 1½ sq. in. area and 0.5 in. sq., which is ¼ sq. in. area, a ratio of 6 : 1. The larger ingate, which represented a figure of 2.9 sq. in. of ingate per cwt. of casting was chosen, because of previous trouble in casting solid with this rate of running. The smaller representing 0.46 in. sq. per cwt. was chosen as one which had proved successful in certain castings when bottom poured. Thus the only difference between each pair of cubes was that the one was filled six times as quickly as the other. The irons used were of the composition shown in Table V. :—

TABLE V.—*Analysis of Iron used to demonstrate the effect of rate of pouring on solidity.*

Iron used.	T.C.	Si.	Mn.	P.	S.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Hard Cylinder ..	2.89	1.14	0.61	0.18	0.126
Soft Cylinder ..	3.28	1.64	0.84	0.62	0.107
Common Grey ..	3.05	2.36	0.94	1.18	0.102

Each iron was cupola-melted and poured with from 8 to 10 per cent. superheat, *i.e.*, 1345, 1310 and 1270 deg. C. respectively, controlling the mould temperature at 100 deg. F. in each case. The cubes were then sectioned vertically through the centre for examination.

The etchings, shown in Figs. 53 and 54, representing the hard cylinder-iron, show the quickly-run block to shrink less than that run slowly, the former presenting a depression in the centre of the top of the block approximately 2 in × 0.3 in. depth, against a depression in the latter of 4½ in. across and 0.8 in. deep, and which, incidentally, is accompanied by a secondary pipe extending to the middle of the block.

A second pair of etchings, Figs. 55 and 56, representing the ordinary cylinder-iron, exhibit somewhat similar features, except that the shrinkage in the top is less in each instance, although the more slowly run cast again presents the greater depression, and is accompanied by an appreciable draw in centre. In each block, however, the central draw approximates the same dimensions. It is interesting to observe the mechanism of solidification of the two blocks and the peculiar segregation in that poured quickly.

The third pair of etchings, Figs. 57 and 58, show that the upper shrink, or depression, decreases as the iron becomes softer, but that the central draw increases. These results confirm the findings of the experiment on solidity published in a Paper read before the Newcastle Branch in April, 1922.

As each of the blocks were cast hot, the ready separation of the sulphide, due to the increased fluid life of the metal, is clearly depicted and emphasises (1) the need of a better understanding of the S.-Mn. balance reaction in cupola-melted iron, (2) of the correct adjustment of casting temperature and the rate of running to the form and requirements of the casting and the life of the metal used, and (3) the value of "dross" heads on castings run from the bottom.

Top Pouring.

In the manufacture of iron castings, the limitations of bottom pouring are manifest to all engaged in the art of casting. To compare with the foregoing experiments, a series of single cubes were made pouring from the top (Fig 37). In deciding to run centrally, by means of a jet 0.25 in. sq., *i.e.*, 0.0625 sq. in. area, it was felt that the nearest approach to ideal conditions would be obtained if the moulds could be completely filled by means of such a small jet, measuring only 1/32nd of the area of the ingate of the quickly-run bottom-cast cube and 1/5th the area of the slowly-run cube. A runner basin almost as large as the casting was used, as shown by Fig. 37. To the surprise of the foreman in charge, the mould filled with the greatest of ease.

The etchings, Figs. 59 and 60, illustrate the relative solidity of two extremes of grey iron, the former containing T.C. 2.65; Si. 0.89; Mn. 0.5; P. 0.18 and S. 0.15 per cent., and the latter, T.C. 3.03; Si. 2.22; Mn. 0.82; P. 0.87 and S. 0.064 per cent., when cast in this way. They demonstrate the possibilities of casting large masses of cast iron, such a propeller bosses, hammer blocks and the like from the top, at such a rate as to feed up solid as the block freezes, although the limitations of the principle, when applied to plastic irons, *i.e.*, irons which freeze through a wide range of temperature without due consideration of rate of solidification, are equally apparent.

Rate of Pouring *v.* Solidity in Castings of Varying Sections.

Mons. Ronceray's well-known example, and the experience of many other notable foundrymen, provide sufficient evidence in themselves of the importance of "rate of pouring" as a factor in the production of solid castings of complex form. As this paper would not be complete without some contribution to this side of the question, the cylinder section, Fig. 36, previously referred to, and a loco stuffing box D., Fig. 35, will be considered.

Cylinder Section.

Photographs A and B, Fig. 61, represent ordinary common grey iron, of T.C. 3.2; Si. 2.1; Mn. 0.7; P. 0.9 and S. 0.078 per cent., when poured quickly and when poured slowly. The former was run by means of ¾ in. × ½ in. ingate, the latter by means of a ¼ in. jet.

It is interesting to observe, that whilst slow running has not completely eliminated the draw in this complex section, it has greatly reduced it.

Stuffing Box.

This is shown in Section D, Fig. 35. When run by a single runner of ½ in. × ⅜ in. at A, the castings were porous in the bore after machining. Running by means of two ¼ in. jets as shown in the sketch, with intensely hot metal, the castings came out uniformly solid.

The metal used for the casting had a short freezing range (chemical composition, T.C. 3.00; Si. 1.5; Mn. 0.7; P. 0.5 and S. 0.08 per cent.). When cast with a metal of longer freezing range than this, sound casting could not be produced, whilst to use a harder metal meant increased casting difficulties. Numerous other castings may be cited where a small jet proved efficacious. In their economic application, however, the foundryman has to decide between the increased cost of pouring each job with excessively hot metal, which, incidentally, is not practical in a large jobbing foundry, and the use of chills and larger ingates which admit of the use of a metal of greater fluid life, a lower casting temperature and larger ingates.

From personal experience, the Author has found that jet-running, to be commercial, must be from the top and not the bottom as suggested by Mons. Ronceray, and in the case of small castings, say under 10 cwts., this method may take the form of ¼ in. holes or 1/16th in. slots of a length determined by the weight, form and requirements of the casting. Speaking broadly, a jet area of 0.05 sq. in. per cwt. of metal is a suitable figure.

It should be noted that the few castings cited for the practical interpretation of the liquid shrinkage experiments have been chosen to demonstrate principles and the possibilities of application of these principles to daily foundry practice, and not to dogmatise on methods of casting.

In conclusion the Author expresses his thanks to the Directors of Messrs. Sir W. G. Armstrong, Whitworth and Company, for their permission to publish this research, which has been conducted in their foundries, and to Messrs. Walsh, Smith and Hudson, for the assistance they have rendered throughout.

THE BRITISH COMMERCIAL SECRETARY at Warsaw (Mr. R. E. Kimens) reports that a local firm are desirous of receiving quotations covering delivery free Danzig from British firms for the supply monthly of 100 tons of hematite pig-iron conforming to the following analysis:—Silicon, 2.3 to 2.5; manganese, 0.5; phosphorus, 0.06; and sulphur, 0.05 per cent. Further particulars can be obtained by interested British firms on application to the Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1.

XUM

An Apprenticeship Course in Foundry Practice.—XXVII.

By Ben Shaw and James Edgar.

LOAM MOULDING.

Part I.

Loam moulding is a type of moulding distinct from either green- or dry-sand moulding, not so much because of any difference in the principles involved, but because of the difference in the manipulation of loam as compared with sand, and in the general preparation of moulds consisting of loam. Loam, for instance, is much more plastic, containing much more moisture than is associated with either green- or dry-sand mixtures, and, in consequence, loam moulds do not need ramming. The loam used in the iron or brass foundry has the appearance of ordinary mud, varying in the degree of stiffness according to the moisture content, whereas that which answers a similar purpose in the steel foundry has a somewhat similar consistency and bears some similarity to ordinary cement, particularly when "compo." is employed in its preparation. Loam is, as a rule, applied by hand, and, because of its composition, loam moulding is generally recognised as the most disagreeable form of moulding. There are compensations, however, which, if they do not give the loam-moulder the benefit of being the most highly-skilled craftsman in the foundry, as many foundrymen assert, give facilities for the use of initiative to a greater extent than is experienced in either green- or dry-sand moulding.

In the preparation of moulds, the loam-moulder requires less pattern-work than either the green- or dry-sand moulder, but, as a rule, more tackle is involved, and in the making of this he is generally responsible. The limited amount of pattern-work with which he is usually supplied reduces the advantage of visualising the finished casting from it. The loam-moulder must, therefore, be conversant with and have the faculty for reading drawings to a greater extent than is necessary for either the green- or dry-sand moulder, who are generally supplied with a pattern and core-boxes more representative of the finished casting. In addition to the ability to determine and make, if necessary, suitable tackle, and prepare a mould in the most economical manner—an essential qualification of the moulder, whatever the class of moulding adopted—must be coupled that degree of foresight which is necessary to the loam-moulder, more particularly because of the amount of pattern-work—sometimes negligible—with which he is supplied, to guide him in defining the shape of the required casting with any degree of accuracy.

The Work of the Loam-Moulder.

The loam-moulder is not only concerned with the making of complete moulds in loam but for large work; he is responsible for the making of cores for dry-sand moulds, and in many foundries it is customary to make the loam-moulder, who has been responsible for the cores of a job, also responsible for coring-up and closing the mould preparatory to casting. His greater familiarity with drawings enables him to check the varying thicknesses as the cores are introduced, and to locate them in their correct relative positions. The connection of the core-vents and the free exit of gases from them during the time of casting is his concern, together with the completion of any part of a core left open for access to a staple to facilitate lifting when it has been finally lowered into its proper position. The work of the loam-moulder also includes the making of loam patterns or "dummies," from which either loam or dry-sand moulds may be made, according to circumstances and the character of the work. In a great many instances loam-coreboxes are prepared, either wholly, or merely forming a seating or cup in which the core can be built. The making of foundation plates, building plates, and rings of various kinds, and also grids, are incidental to the work done on the loam-floor, as it is usually designated, and though the loam-moulder may not necessarily make their moulds on the open-sand-bed, he is nevertheless responsible for marking out their requisite shape, the positions and character of gaggers or prods, if any, to be cast on them, and any staples that may be required to be cast in them.

The Economic Value of Loam.

While any mould can be made in loam, it would be absurd and costly to attempt to make use of it for the majority of castings. It is particularly suitable in work of a cylindrical character, especially large work when the number of castings required are few. In such work a considerable proportion of the pattern-work is unnecessary, because the shape can be defined by means of a sweeping board or strickle having a profiled edge, similar to the cylindrical part of the casting to be made. Even when the work is not cylindrical, it may be of such a character that a skeleton or skeleton shell-pattern could be quickly prepared, from which both mould and cores could be readily produced in loam. Loam is not, as a rule, profitably used for repetition work, certainly not for the making of a complete mould, although it is frequently useful in conjunction with dry-sand moulding and for work of a repetition character. Its great advantage is in reducing the cost of pattern-work for one or two off jobs, and for which it is applicable. It must, however, be remembered that tackle for loam moulding is more costly, and there are additional drying costs as compared with other forms of moulding. Thus, when many castings are required, it may be more profitable to have a full pattern and core-boxes for use in the making of sand moulds, because the cost of the pattern, when spread over the number of castings required, may be small compared to the additional cost of making the castings in loam. When only one or two castings are required, however, by making them in loam moulds, or in sand moulds with the aid of loam, the cost of the pattern-work required is, in many cases, so small that a considerable saving can be effected.

Building Loam Work.

The expression "building" is applied to the process of preparing a loam mould because bricks are employed for the purpose, being used in a similar manner as in house-building construction. The bricks are, however, usually firebricks, and they are interposed with loam instead of cement. These bricks absorb the moisture from the loam very quickly, and particularly when a coating of loam is to be swept on them in a vertical direction. They should have a good supply of water in the first place to assist the loam to adhere to them.

In some instances, when ordinary firebricks cannot be used conveniently, special loam bricks are prepared and dried to be used instead, or small pieces of dried loam may be used when preparing work in loam, to absorb the moisture and thus stiffen the work, quicker than it would otherwise be done. This is necessary to reduce the amount of sagging which is likely to take place, or to prepare the work for a final smoothing coat of very soft loam. Loam moulds are generally built inside gaggers or prods cast on plates, and when the work is comparatively high, rings known as building rings are necessary to maintain the external continuation of the gaggers. The main or foundation plate must be sufficiently strong to support the whole job and to withstand any possible pressure upon it during the time of casting, but the building rings, being only necessary to carry the external gaggers, need not be strong. When a joint is required to be made, then a stronger ring-plate—more properly termed a joint-plate—is necessary to take the weight of the work to be lifted. Building rings should be used about every foot in height, in order that the gaggers

may be effective in supporting the mould against the pressure of the metal when casting. Invariably other precautions are taken to give additional support to the outside of a loam mould sufficient to resist any possible pressure applied by the fluid metal.

Venting Loam Work.

While bricks are used in the building of loam moulds and cores, they must not be built in a haphazard manner. Firebricks offer very poor facilities for the escape of air and gases generated when casting, the loam interposing them being the channel through which the escape is made; it follows, therefore, that the bricks should not be too close together, and the loam between them should be, as far as possible, parallel in thickness. Exhaust chambers are equally as necessary for loam moulds as for those in sand, and cinders or straw may be used for the purpose, pipes being used to convey the gases to convenient places outside the mould. For long cylindrical cores, straw rope or wood wool is used for venting purposes, as it carbonises during the time of drying, leaving the interior of the cores porous, and connecting the vent hole in the hollow mandril upon which the core is swept.

Drying Oven Bogies.

In connection with work on a loam-floor, not infrequently only minor consideration is given to the facilities for conveying loam moulds or cores in and out of the drying oven. The drying oven ought to be adjacent to the loam-floor, into which the work can be conveyed with the least amount of manual effort and with any possibility of jolting reduced to a minimum. Loam, it must be remembered, is a plastic material, and subject to the influence of jolting to such an extent that inequalities of the floor surface over which a bogie is required to run will cause a mould or core carried upon it to sag during transmission to the oven. It is more satisfactory, and more economical eventually, to use rails upon which bogies carrying work can run; there is then little likelihood of any jolting if the rails are correctly set in the floor and continuing into the oven. With rails, the laborious work of conveying the work in and out of the oven is considerably reduced, particularly when a travelling crane is available; then, by means of blocks or pulleys and a suitable wire rope, the work can be drawn in or out of the oven. The bogies should be so designed that they can be readily lifted from the axles carrying the flanged wheels, so that the rails can be kept clear for conveying work as it is ready to be dried. The sizes of bogies can then be varied more readily to accommodate the varying sizes of work.

Loam Mixtures.

Erith sand or loam is used to a considerable extent in England, although red-rock sand is also used, particularly in the Midlands and North-West, for preparing loam mixtures. In Scotland, where loam work is more extensively used than in England, iron sharp-sand is the most important of the loam mixtures. This sand is generally of a coarse nature, and it is comparatively weak in itself, necessitating the use of clay for giving the loam the desirable degree of strength. Erith sand usually contains the requisite amount of bond, although it is not as uniform in strength as some of the red-rock sand. Many sands are used in different parts of the country, supplies being obtained as far as possible from the locality in which the foundry is situated, economy being an important factor.

The mixtures usually consist of three varieties, known as building-loam, fine- or facing-loam, and core-loam. These mixtures are, of course, differently constituted, according to the nature of the work, and different mixtures are known by special names, but generally their names vary with the district, and sometimes with the foundry; therefore it would not serve any useful purpose to refer to them here. The mixtures bear the same relationship to loam work as backing, facing, and core sands in green- or dry-sand work. The building loam, as its name implies, is used for interposing between bricks, whereas the fine- or facing-loam is used to form the face of a loam-mould. More attention must be given to the composition of facing-loam; thus a mixture of three of new sand to one of hard loam obtained from moulds that have been used, and milled together with sufficient water to give the desired plasticity, is an example of a fine loam mixture. Clay may be necessary to increase strength, or either sharp sand or coke may be used to reduce the strength. Chopped straw, or more often horse-manure, may be added to open an otherwise strong mixture. Core-loam mixtures more nearly resemble those used as facing-loams, except that they must be more open in texture; for this purpose either coke, sawdust or chopped straw may be ground with the mixture. In order to make the core loose and friable, so that it will leave a casting readily, blacking is sometimes added to a core-loam mixture, the amount varying with the reduction in strength desirable. Generally speaking, the time occupied in milling a mixture should not exceed about 15 minutes, and it is good practice to mill the dry ingredients for a minute or two before the water is added.

Blacking is used to wash or paint the mould and cores in order that a good skin may be produced on the casting, and also to facilitate cleaning, as in the case of dry-sand moulding, the blackwash mixtures being similar to those referred to in the article on dry-sand moulding.

British Empire Exhibition of Electrical Plant.

We are officially informed that the Council of the British Electrical and Allied Manufacturers' Association have offered to supply to the Exhibition a temporary power station, the value of the plant for which amounts to about £130,000. The turbine station will be complete with switchboards and sub-stations. They are also prepared to supply additional generating plant, if required, amounting in value to over £50,000. This plant will be lent to the Exhibition on terms representing only a small fraction of its value.

Iron and Steel Institute.

The annual meeting of this Institute will take place on Thursday and Friday, May 10 and 11, at the Institution of Civil Engineers, Great George Street, London, S.W.1. The latest date for receiving applications from candidates for election is March 21. The annual dinner will be held on the evening of Thursday, May 10, at the Connaught Rooms, Great Queen Street, London, W.C. Particulars will be circulated later.

Members are reminded that in March the Council is prepared to consider applications for grants from the Carnegie Fund, in aid of research work on some subject of practical importance relating to the metallurgy of iron and steel, or allied subjects. Special application forms can be obtained from the Secretary of the Institute, 28, Victoria Street, Westminster, S.W.1.

A cordial invitation to the members of the Iron and Steel Institute has been received from the President of the Associazione fra gli Industriali Metallurgici Italiani to meet in Italy next autumn. Subject to final arrangements with the Italian Association, the autumn meeting will take place at Milan about the middle of September, and on its conclusion it is proposed that visits should be paid to the principal metallurgical centres and to hydro-electric power stations in Italy. The tour will also include visits to Rome, Naples, Genoa and Turin, and is expected to occupy altogether about 19 or 20 days from the time of leaving London until the return.

Forges et Laminoirs de Baume.—This Belgian concern invites subscriptions for 39,000 new shares, without indicated value, at 265 fcs. each. The general meeting held last October approved of the directors' proposal to double the number of existing shares (55,000). Of the new issue 16,000 were handed to the shareholders of the Soc. Anon. des Laminoirs de la Croyère, whose properties were acquired by the Baume Company.

XUM

Institution of British Foundrymen.

SCOTTISH BRANCH.

The fourth meeting was held at Glasgow on January 13. Mr. W. H. M. Hodgart, the Branch-President, occupied the chair.

Address of Welcome to the President and Secretary.

Mr. Hodgart, at the outset, stated that he had a very pleasing duty to perform, namely, to introduce Mr. H. L. Reason, the President of the Institution, to the members, and on behalf of the Scottish members he extended to Mr. Reason a hearty welcome to the Scottish Branch. Mr. Reason was visiting the Scottish Branch in his official capacity as President of the Institution of British Foundrymen, and at the same time he had kindly consented to give an address on the subject of brassfounding.

Mr. Hodgart then referred to the very cordial welcome which was extended to the members of the Scottish Branch on their visit to the Birmingham Conference last year, and he wished to assure Mr. Reason that the Scottish members appreciated to the highest degree the favours he had shown to them during their stay in that city. These conferences brought the members together and created friendships which would be impossible to establish at their ordinary meetings. The associations thus formed were renewed at each conference, and brought that feeling into their meetings which was characteristic of true brotherliness.

Mr. Hodgart also extended a cordial welcome to Mr. W. G. Hollinworth, the General Secretary, who was also visiting the Branch in his official capacity.

The President's Reply.

Mr. Reason thanked Mr. Hodgart for the kind words he had said, he also thanked the members of the Scottish Branch for the hearty welcome which had been extended to him.

He had received a true Scottish welcome since his arrival in Scotland and he wished to express his highest appreciation for all the kindness which had been shown to him.

Mr. Reason referred to last year's Conference, and was very pleased to hear from the Scottish members that the efforts of the Committee had been so much appreciated. During his connection with the Institution of British Foundrymen he had formed friendships which would be lifelong in their character and the associations which he had made with the Scottish members he would ever remember. The President then referred to the great work which lay before the Institution. Foundry work was the very foundation of the engineering industry; it stood, however, on a platform by itself, and the problems associated with the foundry work were far-reaching in their character.

They hoped in the near future to be assisted in their work by the investigations now being conducted by the British Cast Iron Research Association, a body which had its origin in the Institution of British Foundrymen. Research was necessary in every industry if progress was to be made, and they felt that the Institution of British Foundrymen was only now at the beginning of the work for which it was established.

In this connection he would like to say that the Institution was established to benefit the industry as a whole, and its highest office was open to the humblest member. When the details associated with the Royal Charter had been completed it was proposed to issue a certificate to each member. The membership of the association was about 1,700 and the finances were in a healthy condition. He wished to thank the Scottish Branch for the support which they had always given to the parent body, and he hoped that the good feeling which had always existed would still continue.

Synopsis of Lecture.

Mr. Reason then proceeded with his lecture on brassfounding, and presented his subject by showing a number of lantern slides and making observations on the subjects embraced. The following, among other points, were considered: types of furnaces, coke, gas, and oil fuel; casting temperatures; brass, bronze, and gun metal alloys; composition and physical properties of brass alloys.

Under the first heading Mr. Reason exhibited a number of interesting views of different types of furnaces, chiefly of the pit-fire type, a type of furnace which still holds a very prominent place in the brass foundry, despite the number of different types of furnaces at present on the market.

The cost of melting metal with different kinds of fuel was next considered, and the advantages and disadvantages of coke, gas, and oil were fully stated. Reference was also made to the utility of the reverberatory and electric furnaces in the brass foundry. The effect of casting temperature on the strength and quality of the metal was next dealt with, and diagrams were exhibited showing some very interesting details in connection with this phase of the subject.

A number of graphs were next shown dealing with the composition and physical properties of brass, bronze, and gun metals. It was shown that a thorough knowledge of these were necessary to those associated with the non-ferrous side of foundry work. The lecture was greatly appreciated by the members, and at the close Mr. Reason was accorded a hearty vote of thanks for his most interesting and instructive address.

In the evening the President was entertained to dinner, at which about 50 members attended. Mr. Hodgart, the Branch-President, occupied the chair. An excellent programme of music was provided, and Messrs. Hodgart, Reason, Hollinworth, Riddell, Cameron, Lawrie, and Campion contributed to the evening's entertainment with speeches.

The gathering was thoroughly enjoyed by all, and the singing of "Auld Lang Syne" brought the meeting to a close.

SHEFFIELD BRANCH.

Annual Dinner.

The annual dinner of the Sheffield and District Branch of the Institution of British Foundrymen was held at the King's Head Hotel, Sheffield, on January 19, when there was a very large attendance, under the chairmanship of the Branch-President, Dr. Thomas Swinden. Among those also present were the Lord Mayor of Sheffield (Alderman W. C. Fenton), Mr. H. L. Reason (President of the Institution), Mr. Oliver Stubbs (President-Elect of the Institution), Dr. Longmuir (Director of the British Cast-Iron Research Association), Mr. T. H. Firth (Past-President of the Institution), and others.

MR. OLIVER STUBBS proposed "The City and Commerce of Sheffield." He referred to his recent visit to America with Mr. T. H. Firth, and spoke of the visits they paid to foundries in that country. Sheffield, he said, was to be congratulated on the fact that they had a foundry in Sheffield, at Messrs. Hadfields, which would compare favourably with anything they saw in the United States. The Sheffield Branch was to be congratulated on the fact that it was one of its members (Mr. Harry Brearley) who had invented stainless steel. Then one of the men who was chiefly responsible for the founding of the Sheffield Branch was Dr. Longmuir, whom they were all glad to have with them that night. Referring to the very great difficulty that hampered Sheffield steel industry owing to the extensive unemployment, he said this large body of men included very many who came to Sheffield during the war to work on munitions, and who had remained to become a charge on the local rates. These men came to Sheffield for the good of the country, and Sheffield ought not to be saddled with their maintenance whilst other towns, especially the seaside places, were getting off scot free. He thought the Government should make some special arrangement for helping cities like Sheffield out of the difficulty.

THE LORD MAYOR OF SHEFFIELD, who responded, said that in his profession as an architect he had more or less been connected with the foundry trade. He referred to Sheffield's high rates, due

to unemployment, and said that the Guardians of Sheffield were owing something like three-quarters of a million of money that had been paid in relief. He felt that the Government ought to give the city some special relief, on account of the peculiar situation. The civic authorities had already approached the Government, but had not met with much success. Still, they were going to stick to it, as they hoped that the new broom would sweep cleaner than the old. The rates weighed heavily upon local industry, and impeded its return to prosperity. This was specially so in the steel industry. Still, things were looking brighter, and he had some very cheery information that day. The improvement was gradual, but he hoped that it was going to be permanent.

THE CHAIRMAN proposed the toast of "The Visitors." He also referred to the unemployment in the city and the state of trade, and said that for some time now the employers had been making no money out of industry, but they were looking forward to brighter times.

MR. B. W. METHLEY responded.

The toast of "The Kindred Associations" was proposed by Mr. John Hyde, and responded to by Dr. Longmuir

DR. LONGMUIR said that whilst it was a pleasant thing to have to respond for the kindred associations, he felt that the Institution of Foundrymen held his own interests. At the time of the first dinner of the Institution he was the secretary of the Branch. There were many technical societies in Sheffield, and he referred specially to the Foundry Trades' Technical Society, which was one of many that had been formed at the University by Dr. Ripper and Dr. Desch, with the ultimate object of bringing the worker into touch with the scientific side of the industry. It was 19 years ago since the Institution of British Foundrymen was first started, and he was one of the earliest contributors to THE FOUNDRY TRADE JOURNAL. During its lifetime the Institution had received criticism, but it continued to grow, and would grow, in spite of what was said. It was with great pleasure that he was able to announce to a Sheffield audience that that week the British Cast-Iron Research Association had appointed three graduates as assistants in research. One would work with Prof. Turner at Birmingham, another with Dr. Desch at Sheffield, and the third at offices of the Society in Birmingham. They hoped by that means to link up practice on the one hand with science on the other.

MR. C. K. EVERITT proposed "The Institution of British Foundrymen," and the toast was replied to by Mr. Reason.

MR. REASON reported satisfactory progress in regard to the membership of the Institution, and said that it was now approaching 2,000. It would have been double that figure if it had not been for the trade depression of the last two years. There had, in spite of the difficulties, been an increase in the membership of 200 during the year. He had that day, on behalf of the members, sent congratulations to the Duke of York on his engagement, and had received a reply from Buckingham Palace. Mr. Reason paid tribute to the work that was done in the early days of the Institution, and said that Mr. T. H. Firth, of Sheffield, was largely responsible for the Society's success in obtaining the Royal Charter.

During the evening an admirable musical programme was rendered.

LANCASHIRE BRANCH.

A Successful Social Evening.

Instead of a dinner, the Council this year decided upon a tea and a smoking concert. The Branch-President, Mr. John Haigh, occupied the chair, whose health was proposed by Mr. R. A. Miles, who briefly sketched Mr. Haigh's career from the time he served his apprenticeship in Oldham.

In replying, Mr. Haigh said he had on each side of him two men who had done more than any other two men in Lancashire to raise the status of the foundry trade. Mr. Sherburn was interested in the human side of it; for a long time he had been telling them what ought to be done for the individual foundryman. Mr. Stubbs had a larger sphere, and he was concerned largely with the practical work in the foundry. He had done a great deal for foundrymen, and they had reason to be proud of it.

The industry had been passing through a period of depression which had brought with it a lot of hardship, but also they had gained experience, and were now, not only themselves, but the workmen also, in the more sober and saner frame of mind which was required for successful negotiation and progress. They had needed a lesson, and he believed it had been taken to heart.

At the present time a good deal was heard about the necessity for confidence and credit in order to restore stability to the finances and industries of the country. It was needed individually as well as nationally and internationally. Complete accord between the workmen, the foremen and the directors would enable them to overcome all their difficulties. Slowly but surely that was being built up. The heads of the foundries and engineering establishments had open minds, and so had the employés; when they came together in agreement fuller employment would be assured.

He appealed to the young men to come forward and take their share in the work of the Institution. Hard work, perseverance, diligence and sacrifice had raised the Institution to its present position, and if the young men on the sunny side of thirty would follow the example that had been set by their seniors there need be no fear that the industry would revert to the condition in which it was 20 years ago.

In proposing the toast of "Our Visiting Members," Mr. Stubbs said the British Cast Iron Research Association, which had been mentioned, was going to do very excellent work, and as an Institution they were to be congratulated on the fact that the Director of Research was one of their Past-Presidents—Dr. Longmuir, of Sheffield. He appealed to all foundrymen to interest themselves in it and get their employers to become attached. It was not going to take the place of the I.B.F.

Trade Prospects.

He hoped Mr. Faulkner, in replying to the toast, would say a few words about the International Foundry Congress which was to take place in Paris this year. Efforts were being made to enable some of the members to be there. The more they came together the better they would stand. That week he had met the Executive of the Foundry Trade Union on various questions, and he did not wish to meet a more reasonable body of men. It was very gratifying to the employers to find that there was a better feeling growing up between the men and themselves. If they talked plainly to one another and came together as they did in the Institution they would come to a much better understanding.

This time last year many of them were hopeful that trade was going to be good. They had been disappointed. He could not promise them that 1923 was going to show a boom, but certainly the indications were that there would be an improvement. It was time that it came. If they could get rid of the fallacy that if people worked hard there would not be enough work to go round, and all put their shoulders to the wheel, there should be no need for reductions in wages.

Coming to the subject of the toast, he need say very little about Mr. Buchanan, who was well known to all. He was the first President of the Institution, and he had always been ready to come to its aid. His work for the Institution was tremendous. In Mr. Faulkner they had one of the coming men in the foundry trade, who was looked upon as an expert in electrical furnaces. Personally, he should like to see more work thrown upon Mr. Faulkner's shoulders. The correspondence in the Journal might be very much improved if the members would use the opportunity for expressing their views, and they would have every sympathy.

Mr. Buchanan said one of the pleasures foundrymen got from the Institution was that they were brought together, formed lasting friendships, and on occasions like the present one met many of their old friends. Before it was formed they moved in little orbits of their own. He did not know that the formal meetings were the most valuable. The personal contact with one another,

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the exchange of information in smoke rooms and elsewhere, was most useful. The Institution had broken down the old spirit of exclusiveness and self-containedness which was too much in evidence in former times. They had reason to cherish pride in an industry which called for the highest qualities of intellect and character and experience, and which offered a field for their energies to which no conclusion could be seen. He thought no man present would claim that he knew all about founding or that he was likely to learn it in the future. That gave interest to the work, and inspired efforts towards further advancement.

Mr. Faulkner said the matter of the International Congress in Paris was being gone into very thoroughly, and he was convinced it would be well worth the while of any foundryman to attend it. A strong committee had been formed, and was meeting in London in the near future. In making any arrangements special attention would be given to the requirements of the Midlands, North and Scotland. A session in the English language for the benefit of the British and Americans was being arranged. Opportunities would be afforded of visiting representative French works.

An excellent musical programme occupied the remainder of the evening. The artistes were Messrs. J. Fitton, S. Hayward, A. L. Key, S. G. Smith, J. T. Wade and W. J. Wood, with Mr. H. Mott as accompanist.

Aluminium Copper Alloys.

The 92:8 aluminium-copper alloy, known in the trade as No. 12, can be trusted to have an ultimate strength of 4.4 tons per sq. in. and an elongation of 1 to 1.5 per cent. in a 2-in. length, according to Robert J. Anderson, metallurgist, in Technical Paper 287, just issued by the United States Bureau of Mines. Experiments made by the Bureau of Mines in the preparation of No. 12 alloy do not indicate that one rich alloy is any better than another for introducing copper, as regards dross losses and gas consumption. Small heats of No. 12 alloy may be made conveniently and cheaply by using light-gauge copper sheet or punchings; the solid copper should be added to the liquid aluminium, whereupon it will alloy at relatively low temperatures. Where production is large, as in a foundry pouring 11 to 22 tons of castings in 10 hours, it is safer to employ a rich alloy. The most convenient rich alloy available, taking into consideration brittleness, melting point, and ease of calculation, is the 50:50 alloy. The most desirable method of making up a heat is to charge all the materials together. Technical Paper 287 may be obtained from the Bureau of Mines, Washington, D.C.

Theoretical Advantages of Electric Melting of Brass.

The theoretical advantages of electric brass melting are summarised by the United States Bureau of Mines as follows:—(1) Melting may take place in a neutral or reducing atmosphere, thus minimising loss of metal by oxidation and improving the quality of the product through freedom from oxides; (2) metal of crucible quality may be obtained without the use of crucibles; (3) melting may take place in a tightly closed chamber, or at least in one free from the constant passage of the products of combustion of fuel, and thus losses of volatile metals such as zinc and lead may be reduced. Contamination by sulphur from fuel is avoided; (4) in some types of electric furnaces the temperature may be more readily controlled than in fuel-fired furnaces; (5) in some types of furnaces the molten metal is thoroughly stirred, thus giving a uniform product, even with large heats; (6) there is no handling or storage of fuel, such as coke, coal, or oil, and no ashes have to be removed. The cost of power can be accurately predicted over longer periods than the cost of fuel; (7) working conditions about the furnaces are less dangerous to health and safety of workmen, provided suitable types of furnaces are chosen; (8) the above advantages may be obtained in furnaces of larger capacity than can be used satisfactorily in the fuel-fired crucible types, with resulting greater uniformity of product, lower labour cost, and increased production.

B. Elliott & Company, Limited, tool merchants, have removed from 226, Bishopsgate, E.C.2, to 94, Commercial Street, London, E.1.

The Analysis of Dolomite Bricks.

By "Industry."

Promising attempts have recently been made in the Midlands with the manufacture of dolomite bricks, which are less pure than the ordinary "dead burnt basic," as dolomite is known to commerce, and these impurities introduce difficulties in analysis.

Most works' chemists in the iron and steel industry are familiar with the analysis of basic materials, and do not encounter much difficulty.

The object of this article is to assist those chemists who have had little practice with modern refractory bricks, made of a mixture of fireclay or bauxite, and dolomite, and burnt at a temperature of 1,500 deg. C. In the analysis of ordinary good dolomite, the silica, iron oxides and alumina percentages are small, and treatment of the silica with hydrofluoric acid is unnecessary. A double precipitation of the iron and alumina is sufficient to prevent the lime and magnesia being carried down in the wrong places, thus giving high oxides, and low lime and magnesia content. The CaO is estimated by double precipitation to free it from MgO.

In the case of a brick containing 12 to 15 per cent. of the oxides of iron and aluminium, the analysis is more liable to error in the true percentage of the constituents, although all totalling to 100. Table I., which shows the analysis of the same sample, will explain this:—

Sample No.	I.	II.	III.	IV.	V.	VI.
Silica	5.3	5.25	5.3	5.2	5.3	5.3
Iron oxide ..	8.6	8.70	8.7	8.7	8.7	8.7
Alumina ..	10.3	9.5	7.2	14.1	4.7	3.5
Lime	47.8	47.6	47.3	47.0	48.0	48.2
Magnesia ..	26.5	27.45	30.0	23.5	31.8	32.5
Loss on calcintn.	1.5	1.5	1.5	1.5	1.5	1.8

These analyses were made by members of the staff, who have had considerable experience in the analysis of raw and calcined dolomites.

It will be noticed that the ratio of lime to magnesia is in the wrong proportion to a true dolomite, except in No. 6. The lime content is fairly constant, but the alumina and magnesia are up and down. Analysis No. 4 would condemn an otherwise good brick.

On examination of the alumina, it was found in all cases except No. 6 that magnesia was associated with it, but no lime. In one case, after five precipitations of the iron and alumina, as much as 10 per cent. of the total magnesia was found. It is well known to chemists that ammonium chloride in sufficient quantity is required to prevent the carrying down of the magnesia with the alumina, and in ordinary dolomites the hydrochloric acid used in taking up the dry mass, and in the double precipitation is sufficient to form enough ammonium chloride for the above purpose, with only 2 or 3 per cent of the oxides present. The writer found that in the case of higher oxide content this was not sufficient, and by repeated experiments of adding varying amounts of AmCl to the filtrate from the SiO_2 that the following procedure is best:—

Dissolve a gram of the powdered sample in 12 c.c. of strong HCl, take to dryness with a few drops of HNO_3, S.G. 1.4. Take up with 10 to 15 c.c. HCl, filter off the silica and treat the silica, after burning off, with HF, because some of the Al_2O_3 is combined with the SiO_2 where the silica and oxides are high. After driving off the SiO_2 with the HF, the residue is fused and added to the main filtrate. Then add 10 c.c. HCl and 5 c.c. HNO_3, and make the bulk up to 100 c.c. Make slightly alkaline with AmOH, and bring to boiling point, filter, wash well with hot water, and wash off paper by opening out into the original beaker. Re-dissolve the precipitate in 10 c.c. HCl, and re-precipitate with AmOH, filter and well wash; then proceed as usual with double precipitation of the lime with ammonium oxalate. Sufficient ammonium chloride is formed to keep up the lime and magnesia. The nitric acid is added to form ammonium nitrate, which some authorities say helps to separate the lime from the iron. The writer had no difficulty with the lime content.

In the analysis of fireclays, where the percentage of lime and magnesia is small, it is an easy matter to find none, or only a trace of magnesia, because it is all estimated as alumina. This method carefully carried out will give accurate results.

Trade Talk.

CYRIL W. MASSEY & COMPANY, LIMITED, iron and tinplate merchants, have removed to 88, Gracechurch Street, London, E.C.3.

UNITED BRASSFOUNDERS AND ENGINEERS, LIMITED, have transferred their head office and works from Manchester to Ormskirk, Lancashire.

THE RUMOUR that the Park Gate Iron and Steel Company, Limited, will shortly be amalgamated with another concern, has been officially denied.

MR. W. H. HERBERT, of 44, Plymouth Street, Swansea, has been appointed Bristol representative for the Worcester Brass Company, Limited, Lifford Lane, King's Norton, Birmingham.

OPERATIONS HAVE BEEN RESUMED at Lord Leconfield's "Crowgarth" iron-ore mine at Cleator Moor. Work was suspended early last November, owing to the winding-engine house being burnt down.

A PAPER on "Arc Welding," prepared by Messrs. H. W. Wolton and R. W. Heasman, was read at a meeting of the members of the Staffordshire Iron and Steel Institute at Dudley, on January 19.

NEGOTIATIONS BETWEEN the Birmingham Chamber of Commerce and the London, Midland & Scottish Railway Company have resulted in the scale of reductions on hardware traffic being made applicable to hollow-ware.

MR. J. INGRAM, for many years manager and a director of the Luton Iron Foundry Company, Limited, has established himself in business under the style of Ingram's Foundry Company, at Chaul End Works, Luton

BEFORE THE MEMBERS of the Sheffield Association of Metallurgists and Metallurgical Chemists, on Tuesday, Mr. T. E. Russell read a paper on "The Internal Energy and Elastic Limit of Cold-worked Steel."

AT THE MEETING of the Sheffield File Trade Technical Society on January 18 an interesting lecture was given on "Steels from the Filemaker's Point of View" by Dr. T. Swinden. The chair was occupied by Mr. J. L. Howard.

MARSHALL, SONS & CO., LTD., engineers, Gainsborough, inform us that their senior representative, Mr. Walter L. Keightley, who lately resided at Nottingham, has removed to 78, London Road, Reading, Berks.

MONSIEURS PELNARD-CONSIDÈRE AND CAQUOT have been elected on the English board of directors of Considère Constructions, Limited (formerly Considère Construction Company, Limited), of Victoria Street, London, S.W.1.

BEFORE the Cambridge University Engineering Society, at Cambridge recently, Sir Robert A. Hadfield, Bt., delivered an address on "Advances in the Metallurgy of Iron and Steel and their Influence upon Modern Engineering."

THE SIXTY-SECOND annual dance of the Royal Metal Trades' Pension and Benevolent Society will be held at the Hotel Cecil (Grand Hall), London, W.C., on Friday, February 9. The chairman is Mr. Oswald Nettlefold, J.P., of Nettlefold & Sons, Limited.

THE DOWSON & MASON GAS PLANT COMPANY, LIMITED, have closed down their London office at 3, Manchester Street, W.1. All matters in connection with this department will be dealt with from the head office, Alma Works, Levenshulme, Manchester.

MR. C. K. EVERITT, president of the Sheffield Society of Engineers and Metallurgists, gave an address to the members at the Mappin Hall, Sheffield, on Tuesday, on "Some Achievements and Probable Lines of Progress in the Manufacture of Steel."

THE BECCO ENGINEERING & CHEMICAL COMPANY, LIMITED, have received an order for one of their "Becco-Legg" water softeners, to be used with a range of Babcock & Wilcox boilers at the new works at Keynsham, Somerset, of J. S. Fry & Sons, Limited.

MR. B. MASON, assistant works manager at the Moss Bay Works, Wolverhampton, read a paper on "Steel Melting Furnaces and their Requirements," to the members of the West Cumberland Association of Chemists, Chemical and Metallurgical Engineers, at Wolverhampton. Mr. G. J. Valentine presided.

IN ANTICIPATION of the opening of the new Underground lines, a contract has been placed for a 15,000 kw. turbo alternator for the power station at Lot's Road, Chelsea. The turbines will be constructed by C. A. Parsons & Company, Limited, and the alternator by the Metropolitan-Vickers Electrical Company, Limited.

THE Director of the British Cast Iron Research Association, in his monthly circular for January, announces that the Research Committee have appointed as research assistants Mr. E. C. Dickinson, B.Met. (Lincoln), who will work at the Sheffield University, and Mr. H. J. Simcox, B.Sc. (West Bromwich), to work at the Birmingham University.

Company News.

Peckham Truck and Engineering Company, Limited, Audrey House, Ely Place, London, E.C.—Capital £5,000 in £1 shares.

Norie, Pelmear & Millet, Limited.—Capital £1,500 in 10s. shares. General, mechanical, constructional and electrical engineers.

Atec, Limited, 20, Shirland Mews, Paddington, London W.9.—Capital £500 in £1 shares. Engineers. Directors: A. T. K. Cocquerel and Miss E. L. Cocquerel.

Alto Welding & Engineering Company, Limited, 29A, Portpool Lane, London, W.C.1.—Capital £6,000 in £1 shares. Directors: J. Mackenzie-Russell, G. R. Guinea, and A. W. Macleod.

Laffly (England) Company, Limited, 20-26, Lonsdale Road, Kilburn.—Capital £22,000. Ironfounders, mechanical engineers, etc. Directors: A. Laffly (chairman), S. Tate and R. A. Leroux.

Charles Churchill & Company, Limited.—Loss, £51,282; credit balance brought down reduced to £27,143; preference dividend for half-year to September, 1921, paid; balance dividend postponed; carried forward, £25,343.

William Cooper & Company (Huddersfield), Limited, 7, St. Thomas Road, Huddersfield.—Capital £5,000 in £1 shares (4,000 6 per cent. cumulative preference), to acquire the business of engineers, millwrights, etc., carried on by W. Cooper, F. Jones and N. Avison as William Cooper & Company. Directors: W. Cooper, F. Jones, N. Avison, A. Lunn and P. Cardno.

Yorkshire Railway Wagon Company, Limited.—Available for distribution, £44,347; interim dividend, £9,375; further dividend, 2s. per share on £2 paid and 1s. per share on £1 paid, £9,375; bonus, 2s. and 1s. per share respectively, £9,375; reduction of cost of freehold properties at Horbury, £144; reserve fund, £10,000; carried forward, £6,078.

LIMITED PARTNERSHIP.

B.T.U. Engineering Company, 77A, Stanbury Road, Peckham, London, S.E.15.—Partnership for five years from January 1, 1923. General partners: R. Seasle and A. E. Hefford. Limited partner: H. F. Hefford.

Gazette.

THE SHAREHOLDERS of Nickel Concentration, Limited, have decided to wind up the company voluntarily, with Mr. W. Pocock, 18, St. Swithin's Lane, London, E.C., as liquidator.

MESSRS. J. H. CARTER AND F. CARTER, carrying on business as electrical and mechanical engineers, at 37, Manchester Road, Nelson, under the style of Carter & Company, has been dissolved.

THE SHAREHOLDERS of Stratford Metal Pressings Company, Limited, have decided that the company be wound up voluntarily, with Mr. A. Sissons, 65, London Wall, London, E.C.2, as liquidator.

MESSRS. E. GREENWOOD AND S. G. TROTT, carrying on business as weighing machine makers, at Byram Street, Huddersfield, under the style of Greenwood & Trott, have dissolved partnership.

THE partnership heretofore existing between Messrs. R. O. and J. F. Riley, engineers and metal and machinery merchants, Walkley Lane, Heckmondwike, under the style of Overend & Riley, has been dissolved.

MESSRS. T. BRIGGS, B. BRIGGS, AND J. K. BRIGGS, carrying on business as iron and steel merchants, at 6, Bessbrook Street, and Church Street, Leeds, under the style of B. Briggs & Sons, have dissolved partnership. Mr. B. Briggs will carry on the business.

THE partnership heretofore subsisting between Messrs. A. E. Farrington, O. W. Farrington, and W. T. Perrens, brass founders, Wood Street, Willenhall, under the style of A. O. Farrington & Company, has been dissolved. The two last-named will continue to carry on the business.

The Institution of Production Engineers.

A meeting will be held at 7.30 p.m. on February 2, at the Engineers' Club, Coventry Street, W.1, when Mr. G. E. Turner, general manager of the Cinema Publicity Service, Limited, Ancaster House, 42-43, Cranbourn Street, London, W.C.2, will read a Paper on "The Moving Picture in Industry," to be illustrated by cinematograph pictures. All interested are invited to attend, whether members of the Institution or not, and no tickets are necessary.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The position in the Cleveland iron market during the past week has been dominated by a rapidly growing demand for home consumption, which, coupled with depleted stocks and an almost stationary volume of output, have influenced a strong upward tendency in prices. Buyers who have been holding off the market in anticipation of securing supplies on more favourable terms are consequently finding it increasingly difficult to place orders for forward deliveries, the majority of makers, being fully sold over February, and in many cases still more distant dates, having already closed their books, while any hope that might be entertained of obtaining imported iron has been frustrated by the chaotic condition of the foreign exchanges. In last week's Tees-side market No. 3 G.M.B. was officially advanced to 105s., alike f.o.b. and on trucks, with the result that home consumers find it impossible to purchase at that figure, some of the foundries even discussing the question of closing down unless more reasonable terms can be secured. The effect upon the export trade cannot fail to be very unfortunate, for buyers abroad will not look at current figures. Of late there has been a much better inquiry for export, but there has been practically nothing doing during the last few days. Of course, the scarcity of fuel on the Continent, arising from the occupation of the Ruhr, may change the position, but at the moment exporters despair of putting through business at anything like the figures they are compelled to quote. On the other hand, there may even be a renewal of Continental competition in the home market. Prices of other qualities of Cleveland iron are more or less nominal. There is no No. 1 to be had, and if there were the price, in comparison with No. 3 at, say, 105s., would be 110s. Similarly, No. 4 foundry is about 100s., and No. 4 forge in the neighbourhood of 90s. per ton.

A similar upward tendency of prices as evidenced in ordinary iron may also be noted in the Tees-side market for hematite, for which the home demand is still active, while the advance in cost of fuel and ore has made an increase in values inevitable. This is certain to re-act unfavourably also on export business, inquiry from abroad just now being very meagre. On the other hand, it is impossible to say at the moment what effect the Ruhr crisis is going to have upon the export trade. In the Cleveland market this week sellers of hematite were quoting East Coast mixed numbers at 100s., and 6d. per ton more for No. 1. In the North-West of England the political situation in Europe has had a disturbing effect upon the market for hematite, but with a strong home demand prices have again been firmer, Bessemer mixed numbers now being quoted up to 110s., delivered Glasgow/Sheffield.

MANCHESTER.—The market for foundry iron in the Lancashire area continues steady, with a distinct tendency to advance prices. Ironfounders, it is true, deprecate any rise, and say that the condition of the trade in castings does not justify dearer pig-iron, but it is clear that Derbyshire makers mean to maintain a minimum of 90s. at the furnaces for No. 3, and this would mean rather over 98s. per ton delivered in Manchester. In the Manchester market the sales of Scotch pig-iron are still very much restricted by the price. This is rather higher than it was, and some Scottish makers are now talking of 100s. per ton at the furnaces, as against 92s. 6d. only a short time ago. This would make Scotch No. 3 27s. 6d. per ton above common iron in Manchester, and when the difference was 20s. many founders could not afford to use Scotch. The cost of hematite is less, but the Manchester ironfounder does not find it easy to change his mixtures. Of course, looked at from another point of view, viz., in relation to the Cleveland iron prices, Scotch iron at 100s. is moderate, for it was only a few shillings above the furnace price of Tees-side iron, and this was the customary difference before the war came to upset all markets.

THE MIDLANDS.—Movements in the South Staffordshire iron trade at the moment are chiefly confined to transactions of more immediate importance, sellers evidencing some reluctance to closing business for periods extending beyond the first quarter, to which quotations are mostly confined, while inquiries for extended deliveries are not encouraged, possibly because smelters are in doubt as to what to quote. Obviously they have to protect themselves against a rise in manufacturing costs, but the situation is so obscure that it is difficult to know the extent of the necessary cover. In the meantime they report that deliveries on account of contracts are being taken quite satisfactorily by both forges and foundries, and apart from the old trouble as to the unremunerative nature of business, they have nothing to complain about.

SCOTLAND.—Movements in the Clydeside pig-iron markets have taken a more active turn, while prices—in common with Middlesbrough quotations—have evidenced a stronger tendency, current values now ruling at 98s. 6d. f.o.t. works for No. 3 standard quality Scotch pig. With Cleveland makes almost unobtainable, the local ironmasters consider, and reasonably, that consumers here will turn on to Scotch iron to fill their requirements. In addition to this potential increase in demand, America is sending across urgent inquiries, and several thousand tons have been sold recently for early shipment. The exports to foreign destinations from the Clyde last week were 4,748 tons, as compared with 392 tons for the same week last year. As confirmation of the oft-repeated statement that Scotch iron was being sold at an unremunerative price there is, in spite of the increased demand and higher level of prices, no report to make of an increase in the production. There have been some inquiries in the market for Middlesbrough forge iron for forward delivery, but it is understood that buyers have been unable to cover their requirements, as sellers have withdrawn from the market meantime. Scotch hematite iron is unchanged, but West Coast is probably £5 12s. 6d., though business might possibly be squeezed through at 2s. 6d. less.

Finished Iron.

The improvement previously noted in the conditions applying to finished iron is so far well maintained, and works generally are better employed than has been the case for a long time past. Manufacturers of the better qualities of crown bars now have enough work booked to keep them fully occupied for a couple of months, and they are very firm in their quotation at £11 works. There is still a very steady demand for marked iron, and makers are now fully booked up. It is not thought probable that there will be any increase in their quotation, however. Generally there is still some dissatisfaction with the prices obtainable, for the increases imposed have been offset by the higher costs which have to be met for raw materials and the advance in wages. On the whole, it is stated, the profit margin has not been increased in the same ratio as selling prices have advanced, and apart from the effect of the improved output manufacturers are not much better off. Scotch iron has been advanced 10s.

Scrap.

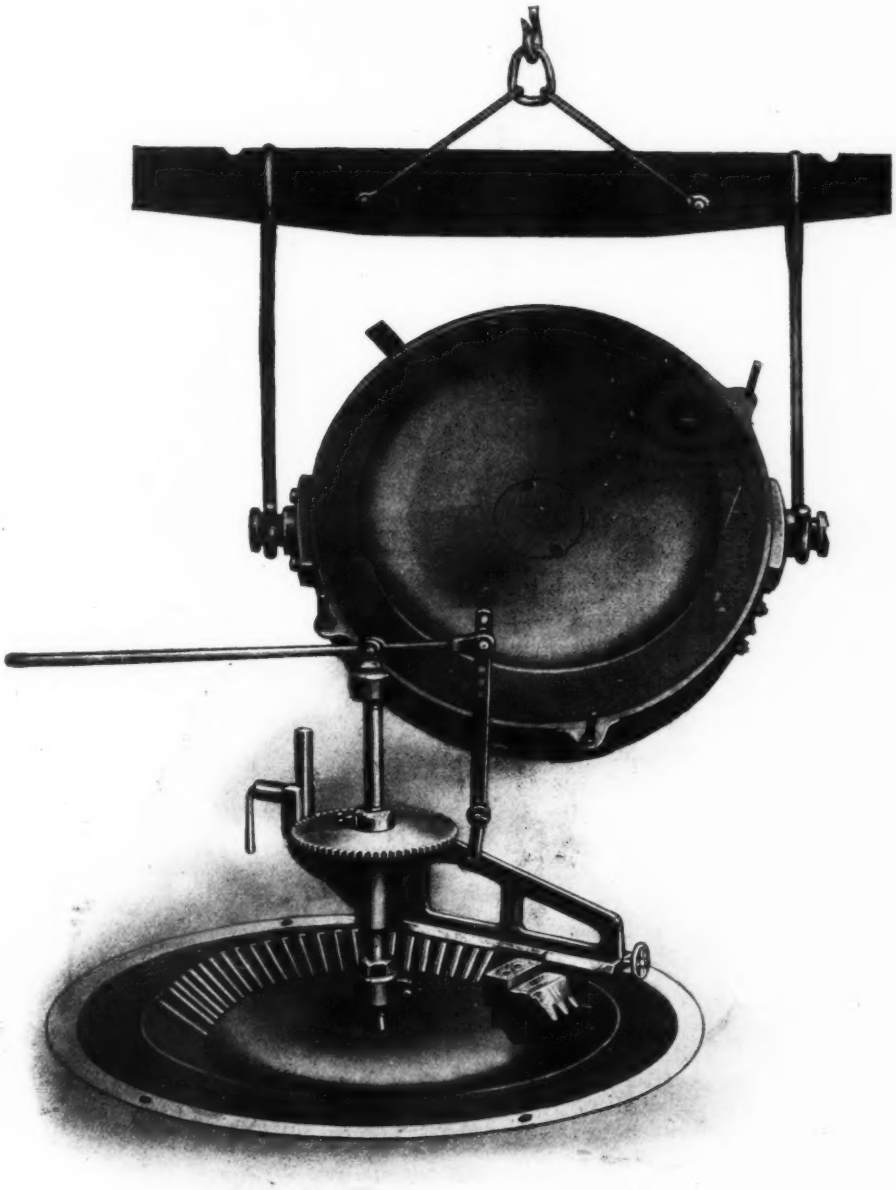
Expansion of the business in iron and steel scrap continues to make steady progress, most of the market centres for this material reporting an active demand, with a sustained tendency to advance values. In Yorkshire stocks are rapidly nearing exhaustion, while production at present is far below consumers' requirements, and will continue so until the steel and engineering trades resume normal activity. The shortage is being keenly felt in the Sheffield district, for more furnaces are being put into operation, and with 40 per cent. of the charge of a modern furnace comprising scrap, it is easy to appreciate the difficulty that is bound to be felt in an increasing degree until supplies are developed. Heavy melting steel is now readily making 85s. per ton delivered, and that it may go higher yet is indicated by the fact that sellers are not inclined to do much forward business at this figure. The present quotation marks a rise of 12s. 6d. per ton in less than two months. Other prices at the time of writing are:—Borings and turnings, 62s. 6d.; builders' light cast-iron scrap, 75s.; cast-iron lumps for basic furnaces, 77s. 6d.; low sulphur and phosphorus acid steel scrap, 92s. 6d.; turnings for electric furnaces, 62s. 6d.; all delivered. There is a growing demand for iron scrap, machinery cast-iron material for foundry use making 90s., and heavy wrought iron 87s. 6d. per ton, both delivered in the West Riding. At Tees-side steel scrap is now in fairly strong demand, with prices ranging from 77s. 6d. to 82s. 6d. per ton. Cast-iron machinery scrap is in fairly good demand, but the prices offering are relatively very low compared with current pig-iron quotations, being only about 80s. to 82s. 6d. per ton. Heavy steel turnings and c.i. borings are stiffer at 62s. 6d. to 65s. per ton. Heavy wrought-iron piling scrap can be bought at 75s., and specially selected heavy forge is 85s. to 90s. per ton. All quotations are delivered works.

Steel.

Conditions in most departments of the steel industry continue to develop on satisfactory lines, the growth of demand on home and export account showing steady progress, while values are also inclining to higher levels. Inquiries at Sheffield are coming forward on

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS,
(MANCHESTER), LIMITED.
BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS,—*Continued.*

an increased scale, the effects of the Franco-Belgian move against Germany having already stimulated fresh orders, business being consequently diverted to this district, which in other circumstances would have been placed on the Continent. There is increased buying of billets, both basic and acid qualities, and all round the market is active. Production is being speeded up, but is, of course, still much below capacity. Substantial orders for railway material are coming in, not only on home account, but for India and the Colonies. In the main the business in steel is for the cheaper qualities, but there is coming a gradual improvement in the demand for the more expensive steels in which Sheffield specialises. Confirmatory evidence of improvement in this direction is furnished in the position of the alloys market, in which there is a steady demand for ferro-manganese on home account, and with the increasing cost of fuel there is every possibility of an early advance in values. For the time being, however, the home price is unaltered at £15. The recent concession of 10s. in the Continental price has not stimulated the demand, and until affairs settle down business with the Continent is not likely to be heavy. The makers have advanced their price to American consumers. The official minimum selling price for tinplates has been raised to 20s. 6d., but there are few, if any, makers willing to sell at this figure, and business was reported in several quarters at 21s. basis. The inquiry is good, and the general tone of the market very firm, prices looking like going still higher, while merchants have been placing option contracts for delivery for the first half of the year. Current quotations for coke tinplates rule firm as follows: I.C. 14 x 20, 112 sheets, 108 lbs., 21s. to 21s. 3d. per box; I.C. 28 x 20, 56 sheets, 108 lbs., 21s. 6d. to 21s. 9d. per box, with option of heavy gauges at 3s. 9d. for the first cross, then 3s. 3d. for each subsequent cross. Light weights stand at ¾d. per lb. reduction. These prices are f.o.b. Bristol Channel ports; for delivery at makers' works, on rails, 3d. basis less; for delivery f.o.b. Liverpool, 9d. basis extra; and 1s. basis extra for delivery f.o.b. London; all net cash.

Metals.

Copper.—Movements in the standard copper market of late have disclosed a revival of interest by bull operators, who have been buying on a more extensive scale, as indicated by a progressive advance in values and a substantial increase in the daily turnover of metal. Events on the Continent have, of course, restricted sales for shipment, but there has been a steady demand for home consumption, counterbalancing the lapse of foreign buying. American advices for some time have been distinctly bullish, and this has been reflected here. Apart from operations to support the recent large Anaconda issues, there seems some justification for the movement. The statistical position of the metal is sound. There is good buying for forward delivery, presumably in anticipation of an improved trade demand over the next few months. Making allowances for a little manipulation, trade authorities regard the outlook as distinctly promising. Current quotations:—*Cash*: Wednesday, £64 15s.; Thursday, £65 7s. 6d.; Friday, £65 12s. 6d.; Monday, £66 2s. 6d.; Tuesday, £65 17s. 6d. *Three Months*: Wednesday, £65 7s. 6d.; Thursday £65 17s. 6d.; Friday, £66 5s.; Monday, £66 17s. 6d.; Tuesday, £66 10s.

Tin.—Business in this section of the metal market has been subject to some irregularity, due to speculative selling from time to time, and the exciting events in Germany. America has again become an active buyer, and this has imparted a firmer feeling to the whole position, the level of values on Friday being very little under the previous week. The American and home tinplate trade is well employed, and everything points to better buying once the political atmosphere becomes clearer. One British maker has recently booked up an order for 300,000 boxes for early shipment to Canada, and this order alone would call for something big in the way of tin. Fresh efforts, it is understood, are about to be made to induce the Government to come to the assistance of Cornish tin-miners. The sub-committee of the Non-ferrous Mines Committee set up by the late Government failed to obtain a promise of assistance from Sir Robert Horne when he was Chancellor of the Exchequer, but they hope to approach his successor, Mr. Stanley Baldwin, with greater chance of success. Current quotations:—*Cash*; Wednesday, £184 5s.; Thursday, £184 5s.; Friday, £185 2s. 6d.; Monday, £186; Tuesday, £186 5s. *Three Months*: Wednesday, £185 15s.; Thursday, £185 17s. 6d.; Friday, £186 12s. 6d.; Monday, £187 10s.; Tuesday, £187 15s.

Spelter.—Consumptive demand for this metal continues in fair volume, but values have shown few fluctuations of importance. On the Continent the market continues steady, and producers there display no anxiety to press sales. In the U.S.A. easier conditions have prevailed, and the price has given way. Statistics there at the end of December, report Messrs. Rudolf Wolff & Company, show the following results: Production, 42,841 tons; deliveries, 33,840 tons; exports, 10,246 tons; stock, 14,000 tons. Current quotations:—*Ordinary*: Wednesday, £35 7s. 6d.; Thursday, £35 12s. 6d.; Friday, £35 15s.; Monday, £36 12s. 6d.; Tuesday, £37 5s.

Lead.—Conditions in the market for soft foreign pig are practically without change, home consumption being well maintained, while the position as regards supplies remains unaltered. Current quotations: *Soft foreign (prompt)*: Wednesday, £27 12s. 6d.; Thursday, £27 15s.; Friday, £28 5s.; Monday, £28 5s.; Tuesday, £28 17s. 6d.

Contracts Open.

Folkestone, February 8.—Supply and delivery of about 1,110 tons of cast-iron pipes and special castings, for the Corporation. Messrs. W. H. Radford & Son, Albion Chambers, King Street, Nottingham. (Fee, £3 3s., returnable.)

Johannesburg, February 14.—Supply of 500 steel tramway tyres, for the Municipal Council of Johannesburg. The Department of Overseas Trade (Room 50), 35, Old Queen Street, S.W.1.

Johannesburg, March 19.—Supply of brass piping, brass and copper sheets, etc., for the South African Railways and Harbours. The Department of Overseas Trade (Room 47), 35, Old Queen Street, London, S.W.1.

London, S.E., February 12.—Supply and delivery of about 3,300 tons of standard steel girder tramway track rails, lipless track rails and renewable guard rails, with fastenings therefor, and, alternatively, of about 4,900 tons of such rails, with fastenings, for the London County Council. The Chief Engineer of the Council, Old County Hall, Spring Gardens, S.W.1. (Fee, £2, returnable.)

London, W., February 6.—Supply of about 580 tons of steel girders and other iron and steel work of British manufacture, for the Great Western Railway Company. The Engineer, Paddington Station.

Lowestoft, January 29.—Supply of 120 tons of 1-in. round mild-steel reinforced bars, for the Corporation. Mr. S. W. Mobbs, borough surveyor, Town Hall, Lowestoft.

Leeds, February 19.—Supply of bolts, nuts and washers, drills, pliers, files, etc., iron and steel, iron and steel castings, malleable iron castings, tool steel and springs, for the Tramways and Highways Committee. Mr. J. B. Hamilton, general and commercial manager, 1, Swinegate, Leeds.

Warsaw.—Supply monthly for a firm at Warsaw of 100 tons of hematite pig-iron conforming to the following analysis:—Si, 2.3 to 2.5 per cent.; Mn, 0.5 per cent.; P, 0.06 per cent.; S, 0.05 per cent. The Department of Overseas Trade, 35, Old Queen Street, Westminster London, S.W.1.

Deaths.

Mr. Clitheroe, of J. Clitheroe & Sons, brassfounders, Canterbury Street, Blackburn, died recently in his seventy-third year.

Mr. Ainslie, for over thirty years director of the North Lonsdale Iron and Steel Company, Limited, of Ulverston, Lancs, died recently.

Mr. William Dickens died at his residence, 48, Neville Street, Cardiff, on Monday. Born in Newport 78 years ago, Mr. Dickens was engaged in brass and other foundry works up to four years ago, when he retired. He was the proprietor of the Cardiff Brass and Patent Metal Works for about 30 years.

Mr. Fred Harper, son of the late Mr. John Harper, of Bilston, and a justice of the peace for the Bilston Division, has died at Cheltenham. Mr. Harper was associated with the firm of John Harper & Company, Limited, Albion Engineering Works, Willenhall, of which he became chairman on the death of his father 20 years ago.

Calendars Received.

Messrs. **August's Muffle Furnaces,** Limited, Halifax; **Grandidge & Mansergh,** Limited, Wheathill Street, Salford, Manchester; The **Metropolitan-Vickers** Electrical Company, Limited, Trafford Park, Manchester; The **Milner Hurd's** Patent Company, Limited, 4, Paradise Square, Sheffield; and **H. A. J. Rang,** St. Nicholas Buildings, Newcastle-on-Tyne.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

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GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

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CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	65	17	6
Three months	66	10	0
Electrolytic	73	0	0
Tough	69	10	0
Best selected	69	10	0
Sheets	96	0	0
India	82	10	0
Wire bars	73	0	0
Do. Feb.	73	0	0
Do. Mar.	73	0	0
Ingot bars	73	0	0
H.C. wire rods	76	15	0
Off. aver. cash, Dec. 63	6	9	16/19
Do. 3 mths., Dec. 64	2	9	15/19
Do. Settlement Dec. 63	5	9	16/19
Do. Electro, Dec. 70	6	3	15/19
Do. B.S., Dec.	67	10	0
Aver. spot price, copper, Dec.	63	5	9½
Do. Electro, Dec.	70	10	0
Solid drawn tubes			13½d.
Brazed tubes			13½d.
Wire			10½d.
Yellow metal rods			6¾d.
Do. 4x4 Squares			8¼d.
Do. 4x3 Sheets			9¼d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10¾d.
Rods, extruded or rolled	6¼d.
Sheets to 10 w.g.	10d.
Wire	9¾d.
Rolled metal	9½d.

TIN.

	£	s.	d.
Standard cash	186	5	0
Three months	187	15	0
English	186	5	0
Bars	188	0	0
Chinese	184	0	0
Straits	188	0	0
Australian	187	10	0
Eastern	191	5	0
Banca	187	10	0
Off. aver., cash, Dec.	178	15	6 6/10
Do. 3 mths., Dec.	180	0	3 15/10
Do. Sttlment, Dec.	178	18	3 2/10
Aver. spot, Dec.	178	14	2½

SPELTER.

	£	s.	d.
Ordinary	37	5	0
Remelted	35	10	0
Hard	29	0	0
Electro 99.9	42	5	0
English	38	10	0
India	30	10	0
Prime Western	38	0	0
Zinc dust	49	10	0
Zinc ashes	13	0	0
Off. aver., Dec.	36	4	11 6/10
Aver., spot, Dec.	37	15	1½

LEAD.

	£	s.	d.
Soft foreign ppt	28	17	6
English	29	15	0
Off. average, Dec.	25	15	9 2/10
Average spot, Dec.	26	1	7

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	44	0	0
Do. V.M. ex whf.	42	0	0
Dutch	42	0	0
Rods	49	0	0
Boiler plates	41	0	0
Battery plates	42	0	0

ANTIMONY.

	£	s.	d.
English regulus	27	0	0
Special brands	33	10	0
Chinese	24	10	0
Crude	18	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	10	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—

	£	s.	d.
45/50%	11	17	6
75%	20	10	0

Ferro-vanadium—
35/40% .. 17/- lb. va.

Ferro-molybdenum—
70/75% c. free 9/3 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/1½ lb.

Ferro-phosphorus, 20/23%, £23

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/10½lb.

Ferro-chrome—

4/6% car.	£21 10
6/8% car.	£20 15
8/10% car.	£20 0

Ferro-chrome—

Max. 2% car.	£53 0
Max. 1% car.	£64 0
Max. 0.70% car.	£72 0
67/70%, carbonless	1/6½lb.

Nickel—99%, cubes or pellets .. £130 0

Cobalt metal—98/99% 11/3 lb.

Aluminium—98/99% £95

Metallic Chromium—
96/98% .. .. 4/6 lb.

Ferro-manganese (net)—

76/80%, loose	£15
76/80%, packed	£16
76/80%, export	£14

Metallic manganese—
94/96%, carbonless 2/3 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. .. 3d. lb.
Packing .. .. £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel	4	5	0	4	10	0
Bundled steel & shearings	3	14	0	4	0	0
Mixed iron & steel	3	12	6	3	17	6
Heavy cast iron	3	15	0	3	17	6
Good machinery for foundries	4	0	0	4	5	0

Cleveland—	£	s.	d.
Heavy steel	4	0	0
Steel turnings	3	3	9
Cast-iron borings	3	3	9
Heavy forge	4	7	6
Bushelled scrap	3	15	0
Cast-iron scrap	4	1	3

Lancashire—	£	s.	d.
Cast-iron scrap	4	3	9
Heavy wrought	3	15	0
Steel turnings	2	15	0

London—	£	s.	d.
Copper (clean)	5	0	0
Brass (clean)	34	0	0
Lead (less usual draft)	23	0	0
Tea lead	20	0	0
Zinc	23	0	0
New aluminium cuttings	64	0	0
Braziery copper	49	0	0
Gun metal	44	0	0
Hollow pewter	150	0	0
Shaped black pewter	90	0	0

Above are merchants' buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	110/-
Foundry No. 3	105/-
Forge No. 4	90/-
Mottled	87/6
Hematite No. 1	100/6
Hematite M/Nos.	100/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast, ord.	200/-
,, ,, roll iron	210/-
,, basic	—
Northants forge	77/6
,, foundry No. 3	85/-
,, basic	—
Derbyshire forge	82/6
,, foundry No. 3	90/-
,, basic	—
Scotland—	
Foundry No. 1	103/6
,, No. 3	98/6
Hematite M/Nos.	105/-
Sheffield (d/d district)—	
Derby forge	85/-
,, foundry No. 3	87/6
Lincs. forge	86/6
,, foundry No. 3	87/6
,, basic	86/6
E.C. hematite	110/3
W.C. hematite	110/-
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	98/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	113/-
Glengarnock foundry	114/6
Gartsherrie foundry	113/-
Monkland foundry	113/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	11	10	0
Nut and bolt	10	2	6
Hoops	15	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	£10/15 to £11		
Bolts and nuts, ¾ in. × 4 in.	16	10	0
Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	£12/10 to £13		
Chequer plates	10	5	0
Angles	9	0	0
Tees	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3 in. to 5½ in.	11	0	0
Rounds under 3 in. to ⅞ in.	10	15	0
Flats, over 5 in. wide and up	11	5	0
Flats, 5 in. to 1½ in.	10	10	0

	£	s.	d.
Rails, heavy	9	0	0
Fishplates	13	0	0
Hoops	11	10	0
Black sheets, 24 g.	12	5	0
Galv. cor. sheets, 24 g.	18	10	0
Galv. fencing wire. 8 g. plain	16	0	0
Rivets, ¾ in. dia.	11	15	0
Billets, soft 7	0 0 to 8	0	0
Billets, hard 8	0 0 to 8	15	0
Sheet bars 7	12 6 to 7	15	0
Tin bars	8	1	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3½
Wire	1 3¾
Rods	1 2¼
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4½ to 1/10½
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6½ to 2/0½
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	29.76
No. 2 foundry, Valley	27.00
No. 2 foundry, Birm.	23.00
Basic	27.96
Bessemer	29.27
Malleable	28.96
Grey forge	28.27
Ferro-manganese 80% delivered	107.50
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	37.50
O.-h. billets	37.50
O.-h. sheet bars	37.50
Wire rods	47.50
	Cents.
Iron bars, Phila.	2.32
Steel bars	2.00
Tank plates	2.10
Beams, etc.	2.10
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/- to 40/-
,, furnace	25/- to 27/6
Durham & North.fdy.	30/-
,, furnace	27/6
Other Districts, foundry	30/-
,, furnace	26/6

SWEDISH IRON.

Bars, hammered basis sizes—Basis price £22 to £23

	£ s. d.
Rolled Ordinary—Assortment ..	16 10 0
Nail Rods—	
Square, round and flats ..	17 5 0

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded .. .. £13 to £14

Pig-iron—
Grey, white or mottled £6 10 to £7 5 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas .. ..57½% } Tube prices
Water ..52½% } are
Steam ..47½% } now free.

TINPLATES.

I.C.Cokes,	20×14, box	21/1½
,,	28×20, ,,	43/–
,,	20×10, ,,	30/3
,,	18¾×14, ,,	21/4½
I.X.	,,	47/6
I.X.X.	,,	53/6
F.C.B.Y.	21×13⅜ ,,	38/6
C.V.B.G.	16¾×15, ,,	36/6
I.C.W.	20×14, ,,	18/7½
,,	28×20, ,,	37/3
,,	20×10, ,,	26/7½
,,	18¾×14, ,,	19/1½
Terneplates,	28×20, ,,	40/–

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Jan. 24	64	15	0	No change	
,, 25	65	7	6	inc.	12/6
,, 26	65	12	6	,,	5/–
,, 29	66	2	6	,,	10/–
,, 30	65	17	6	dec.	5/–

Electrolytic Copper.

Jan. 24	71	10	0	No change	
,, 25	71	15	0	inc.	5/–
,, 26	72	5	0	,,	10/–
,, 29	72	10	0	,,	5/–
,, 30	73	0	0	,,	10/–

Standard Tin (cash).

Jan. 24	184	5	0	inc.	10/–
,, 25	184	5	0	No change	
,, 26	185	2	6	inc.	17/6
,, 29	186	0	0	,,	17/6
,, 30	186	5	0	,,	5/–

Tin (English ingots).

Jan. 24	184	5	0	inc.	10/–
,, 25	184	5	0	No change	
,, 26	185	2	6	inc.	17/6
,, 29	186	0	0	,,	17/6
,, 30	186	5	0	,,	5/–

Zinc Sheets (English).

Jan. 24	44	0	0	No change	
,, 25	44	0	0	,,	
,, 26	44	0	0	,,	
,, 29	44	0	0	,,	
,, 30	44	0	0	,,	

Spelter (ordinary).

Jan. 24	35	7	6	inc.	2/6
,, 25	35	12	6	,,	5/–
,, 26	35	15	0	,,	2/6
,, 29	36	12	6	,,	17/6
,, 30	37	5	0	,,	12/6

Lead (English).

Jan 24	28	15	0	inc.	10/–
,, 25	28	15	0	No change	
,, 26	29	5	0	inc.	10/–
,, 29	29	5	0	No change	
,, 30	29	15	0	inc.	10/–

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

SHROPSHIRE IRON Co., Ltd.

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Hadley, Shropshire.

London:—10, Bush Lane, Cannon St., E.C.4.

Telegrams:—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephone:—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.

Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
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